procedure

1. Check to see that the diode filament is lit.
2. Check tube V2 in a tube tester or replace with a spare.
3. Check V2 grid voltage to cathode or ground. If this voltage is abnormally positive, or zero, check contacts, connections and resistance values of all components of the bridge. Check diode or replace with a spare. Check bridge rectifier.
4. Check the voltage adjusting potentiometer for dirty contacts.

problem D Drift with Age of the Range of Output Voltage.

This condition indicates a variation of tube characteristics with age.

procedure

1. Check tubes and replace accordingly.

problem E Reduction of Regu Poor Regulation in

These conditions may be the result failure of various components of the

procedure

1. Check tubes or replace with spa
2. Check the DC Power supply v
3. Check the control circuit in connections, shorts or damaged
4. Check voltage and resistance v densers by replacement.
5. The output voltage adjustable cause irregular output adjustm tentiometer shaft several times as far as it will go. This is a adjustment and contacts can cause uneven control.

In the event of serious trouble or d return it to the factory for repair an

SORENSEN & COMPANY, INC.
375 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

MANUFACTURERS OF VOLTAGE REGULATORS, NOBATRONS AND ELECTRONIC APPARATUS

INSTRUCTIONS GEI-19645-K

HC-25-C1 CATHODE RAY OSCILLOGRAPH

CATALOG #5142111G1

GENERAL ELECTRIC CO.

SCHENECTADY, N.Y.

May, 1950

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

HC-25-G1 CATHODE RAY OSCILLOGRAPH

Catalog #514211G1

I. INTRODUCTION

The HC-25-G1 cathode ray oscillograph is an oscillograph for the observation and photographic recording of high speed transients such as produced by surge generators or by sudden changes in a circuit. Its visualizing element is a cathode ray tube of hot cathode sealed off design whose screen may be photographed by a camera and simultaneously viewed by the operator.

II. DESCRIPTION

Photograph No. 1081809 shows an oblique front view, photograph No. 1081810 a rear internal view and photograph No. 1081811 an internal side view showing the sweep chassis. The cabinet is about 27" x 27" x 70" and all controls are above the 30" level so that a table or desk may be built around it.

In the back a full sized door gives easy access to all components and connecting cables are coupled to connectors on a narrow panel at the bottom. Near the top is the cathode ray tube with a magnetic shield around it. Attached to the shield is a metal box containing the resistance voltage divider and the selector switch and the oscillator chassis is attached to the bottom of this box. On the next lower level are the 300 volt and 900 volt power supplies for the sweep circuit. At the bottom are the 25 KV power supply for the cathode ray tube and a voltage regulator. The sweep chassis is mounted on the left side so that

its inside connections are accessible when the side panel is removed.

III. SETTING UP

The oscillograph is shipped with all tubes packed separately. The small tube sockets are marked with the tube type numbers. The instruction book on the voltage regulator shows locations of its tubes. The D.C. calibration circuit is on the front panel and its tubes mount horizontally.

The cathode ray tube 5RP2A is installed as follows: 1 extra available

1. Remove top of cabinet.
2. Remove top of magnetic shield.
3. Place tube in shield in approximate position with accelerator ring terminals to left.
4. Connect leads to rings in same order in which they come thru right side of shield.
5. Connect other leads according to tag numbers to deflection terminals which are counted 1 to 5 in a counterclockwise direction looking from socket end. ?
6. Replace top of shield being careful to see that high voltage leads are properly placed.
7. Turn tube so that ring terminals are on horizontal center line.
8. Adjust lengthwise so that screen is 2" back from front panel.
9. Adjust deflection and sweep leads for maximum separation from each other.

IV. CIRCUIT DESCRIPTION

1. 115 Volt Circuits, M-5113137

This shows the 115 volt wiring and is fairly obvious. A ime delay relay provides a one minute interval for filament eating before high voltage circuits can be turned on. ~~Neon~~ Incandescent lamps n ~~parallel~~ Series with fuses will indicate a blown fuse. The saturated ore type voltage regulator provides ±0.2% regulation for the igh voltage supplies.

2. High Voltage Circuits, M-5113134

This shows the excitation, and deflection circuits of the athode ray tube in detail.

The cathode excitation consists of two sources, one a -4 KV alf wave rectifier with 0.5 MA divider and a +21 KV voltage doubler ircuit with 0.35 MA divider. Jacks on the front panel permit lugging in a milliameter in the ground ends of the resistance ividers. The current values marked on these jacks are only ominal and some variation may be expected.

The deflection selector switch provides forward and reversed onnections of the deflection plates. This permits deflection n the same direction for either polarity of deflection voltage. ertical bias on the deflection in either direction is obtained by ontrol of the voltage on the plate which otherwise would be grounded.

The resistance voltage divider provides 75 ohm termination for he deflection cable with ratio steps as shown.

3. Power Supplies, 300V-M-5113146, 900V-M-5113147

These are conventional full wave rectifiers with filters. here is also a -640V supply on the 300V chassis for bias and alibration purposes.

4. Calibration Circuits M-5113150

This shows the D.C. calibration circuit and the timing wave oscillator. The D.C. voltage is held constant by VR tubes and wire wound precision resistors. An occasional check with a milliameter plugged into the jack on the front panel is necessary to maintain accuracy. The 50,000 ohm potentiometer may be adjusted with a screwdriver thru a hole in the front panel until the meter reads 2.50 milliamperes.

The oscillator has four tuned circuits which are adjusted to better than ± 1%. Better accuracy than this is unnecessary as precise correlation between voltage and time elements in impulse testing is hardly possible anyway.

5. Sweep Circuit M-5113143

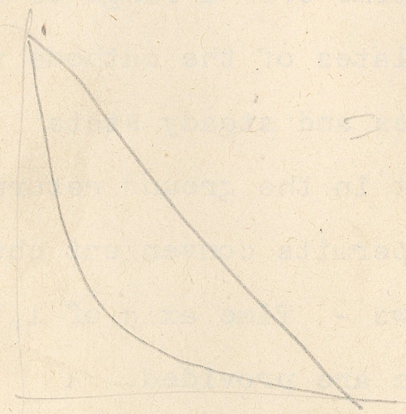
The purpose of this circuit is to produce two voltages of opposite polarity varying linearly with time over a range of some 500 V which connected to the time axis plates of the cathode ray tube produce a linear time axis. Voltages and steady state currents are shown for each tube. A jack in the ground return of each tube carrying steady state current permits convenient checking of tube currents. Operation is as follows - Time axis of 1, 2, 5, 15, 35, 70, 250 and 1000 micro-seconds are provided. A positive pulse of about 25 volts is received on the input terminal from the time delay circuit (described later). This is inverted by tube 1 and fed into tube 2 which with tube 3 constitutes a multivibrator circuit. This triggers off the multivibrator with the result of a square front pulse being put out by tube 3. This cuts off tubes 4 and 5. Cutting off tube 4 causes its plate

$Q = CE$

$\frac{dQ}{dt} = i = C \frac{de}{dt} \quad \frac{-2}{5}$

$i = \frac{200 \times 10^{-12} \times 1000}{10^{-7}}$

$i = 2000 \times 10^{-3}$



oltage to rise 200 volts. This 200 V pulse is coupled to the ontrol grid of the cathode ray tube and serves to reduce its bias o that the beam is established.

Cutting off of tube 5 permits tube 6 to continue carrying its teady state current by drawing upon the charged capacitor C. The inear discharge of C produces the driving signal for tube 7 which n turn drives the final push pull tubes 8 and 9.

As the sweep progresses the current in tube 8 rises and consequently the drop across its cathode bias potentiometer. The otentiometer provides an adjustable feedback signal which drives he multivibrator back to its steady state condition thereby shutting ff the beam at the end of the time axis.

This circuit is somewhat critical of the type of pulse that ill trigger it. A steep front of +20 volts or so with slow unidirectional tail is preferred. With slower fronts greater amplitude s required especially with the faster sweeps. Oscillations in he signal may cause disturbances in the multivibrator resulting n a shortened sweep or other irregularities.

6. Time Delay Circuit M-5113145

This is built into the sweep circuit chassis and its terminals re shared with the sweep terminals. To trace its action it is ecessary to refer to the 115 volt circuit diagram M-5113137.

The purpose of this circuit is to provide the initiating ulse for the sweep circuit and a positive pulse of higher value or tripping a thyratron in the trip surge generator. This enerator is a separate piece of equipment used for coordinating he oscillograph and a large surge generator. The time interval etween these two pulses is adjustable by means of the resistor R

hich is on a tap switch geared to the sweep switch. Fine adjustment s by means of the variable capacitor.

Pushing the green button closes relay 2 first and then relay 1. elay 2 prevents firing of tube 2 and relay 1 causes firing of tube 1. erminal 3 is either grounded solidly or thru a synchronous switch ssociated with other surge generator equipment.

For observing surge generator transients the red button is perated closing only relay 1. When tube 1 fires, the grid of tube 2 s started upward thru resistor R and as it changes from negative o positive it fires. This sends a positive pulse out to trip the rip surge generator.

. PHOTOGRAPHIC RECORDING

The camera is mounted on the front of the camera holder with ontrol knobs on the top and is held in place by two knurled nuts. ts lens speed of F1.5 is required only on the faster sweeps. F4 r even F6 will give good results on the slowest ones. Eastman uper pan XX35/mm film and D72 developer has been used for years lthough there may be some faster films now available such as inagraph Pan.

On the bottom side there is a small catch which may be turned 0 degrees to remove the top half of the film holder. The film pool is placed in the left end and the film moved toward the right y turning the winding knob as shown by the arrow. When a roll is inished, the winding knob will not turn and the film must be ewound into its original container before removal. Before re-rolling e winding knob is pulled out about 1/8" to release the free wheel echanism in it which keeps the film tight. Near (on next page)

the winding knob there is a small button which must be pressed to allow winding up each new exposure. However, in this application two or three records may be taken on the space provided for an exposure by moving the film less than the full amount each time.

A solenoid operated shutter is located inside the camera holder. It may be turned off by means of the shutter switch on top of the camera housing. The lens shutter is normally left open and all recording done with the solenoid shutter. An interlock on the solenoid shutter prevents time delay circuit operation before the shutter is fully open.

VI. OPERATION

Connecting cables all attach at the lower rear panel. A three conductor plug carries 115 volt 60 cycle supply and ground leads. Other coaxial cable plugs are marked and are for -

1. resistance voltage divider
2. deflection plate
3. pulse and bias to trip surge generator
4. for connection to synchronous switch or ground.

The 115V switch is closed first and after a minute for heating the 900 volt switch is closed. The 300 volt switch should be closed a few seconds later. This is to prevent excessive screen grid currents in the 4D32 tubes which would flow if the procedure was reversed. The 25 KV is turned on last after making sure that the intensity knob is on zero. It is a good precaution to be looking in at the screen whenever turning on the cathode excitation and to keep one's fingers on the switch ready to turn it off in

case of any trouble. If the cathode beam is established in a spot with any intensity it will melt a hole in the screen in a few seconds.

For long life the tube should be operated at intensities as low as will give good results for the particular type of work being done.

Operating potentials on the grid and focusing anode vary from tube to tube and therefore three extra potentiometers are mounted on the beam control sub-panel for making adjustments beyond the range of the dial controls.

These potentiometers are shown on the high voltage circuit diagram. The one near the intensity control is set so that with the intensity control on zero the slowest sweep is just barely visible. The two near the focus potentiometer are always operated together so that they both have the same angular setting. These are adjusted to bring the focus points near the middle of the dial. Focus knob setting will remain about constant for all sweeps except the two fast ones. For these two it will require turning one way or the other perhaps a half turn

VII. <u>TROUBLE SHOOTING</u>

1. Loss of Intensity. Check 4KV and 21KV resistor currents in jack with milliameter. 21KV will be low if one rectifier tube fails.

2. Trouble in sweep. Check tube currents with plug-in milliameter. Check all voltage points. Check tubes. Look for burned out resistors or broken down capacitors.

3. Poor focus on film with good focus on screen. Check tube osition. Screen should be 2" back from panel.

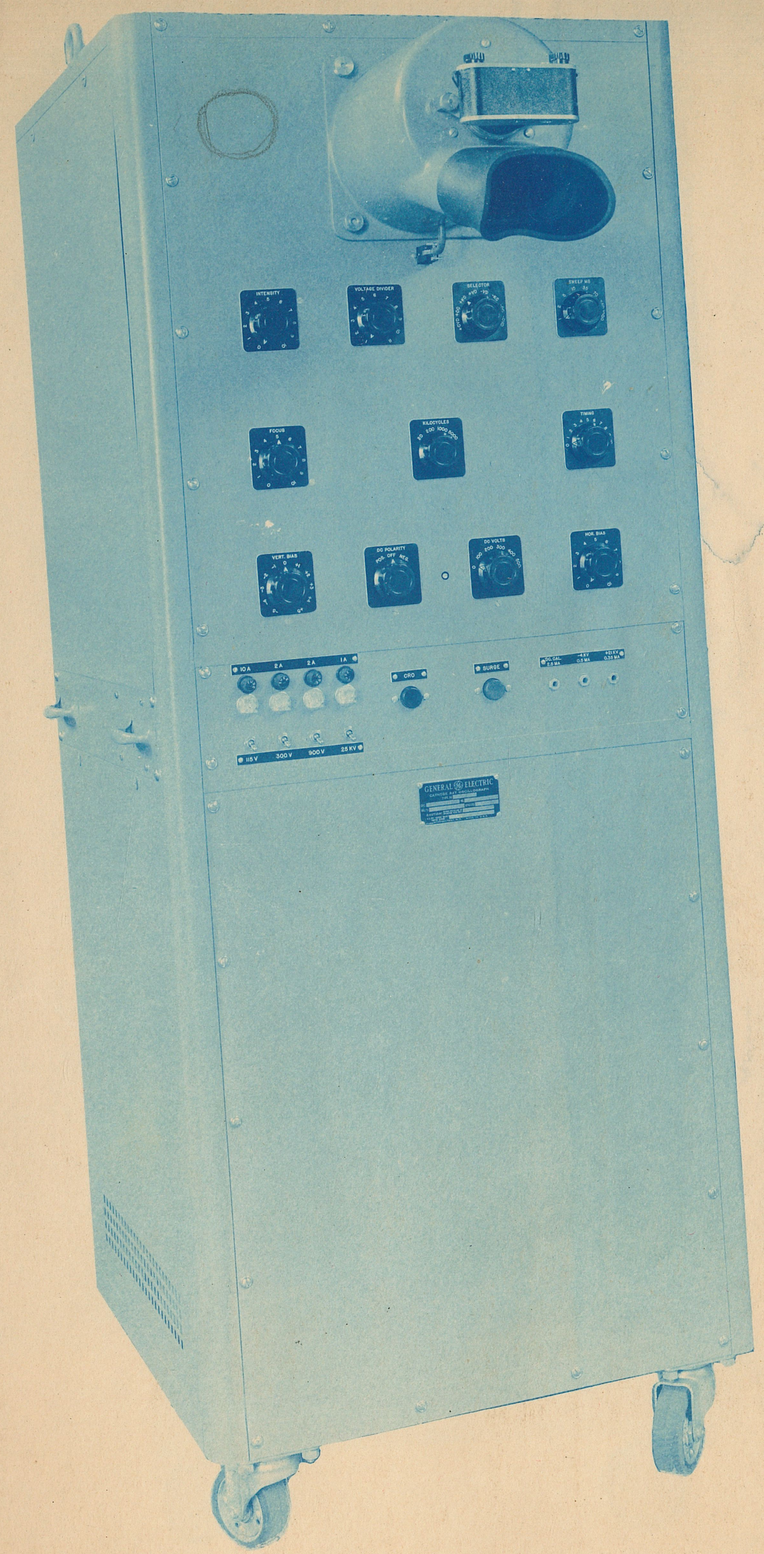
Of course with a complex instrument of this kind there can be s many causes of trouble as there are components and trouble hooting instructions would fill a book if everything was included. herefore, no attempt will be made to go into more detail. A areful study of the diagrams and a good understanding of the theories nvolved will help more than a lengthy instruction book.

III. RENEWAL PARTS

Order 5RP2A (green long persistance screen) or 5RP11A (blue short ersistance screen) cathode ray tubes direct from the Allen B. umont Company. Other parts from the General Electric Company, chenectady - General Engineering and Consulting Laboratory.

X. CAUTIONS

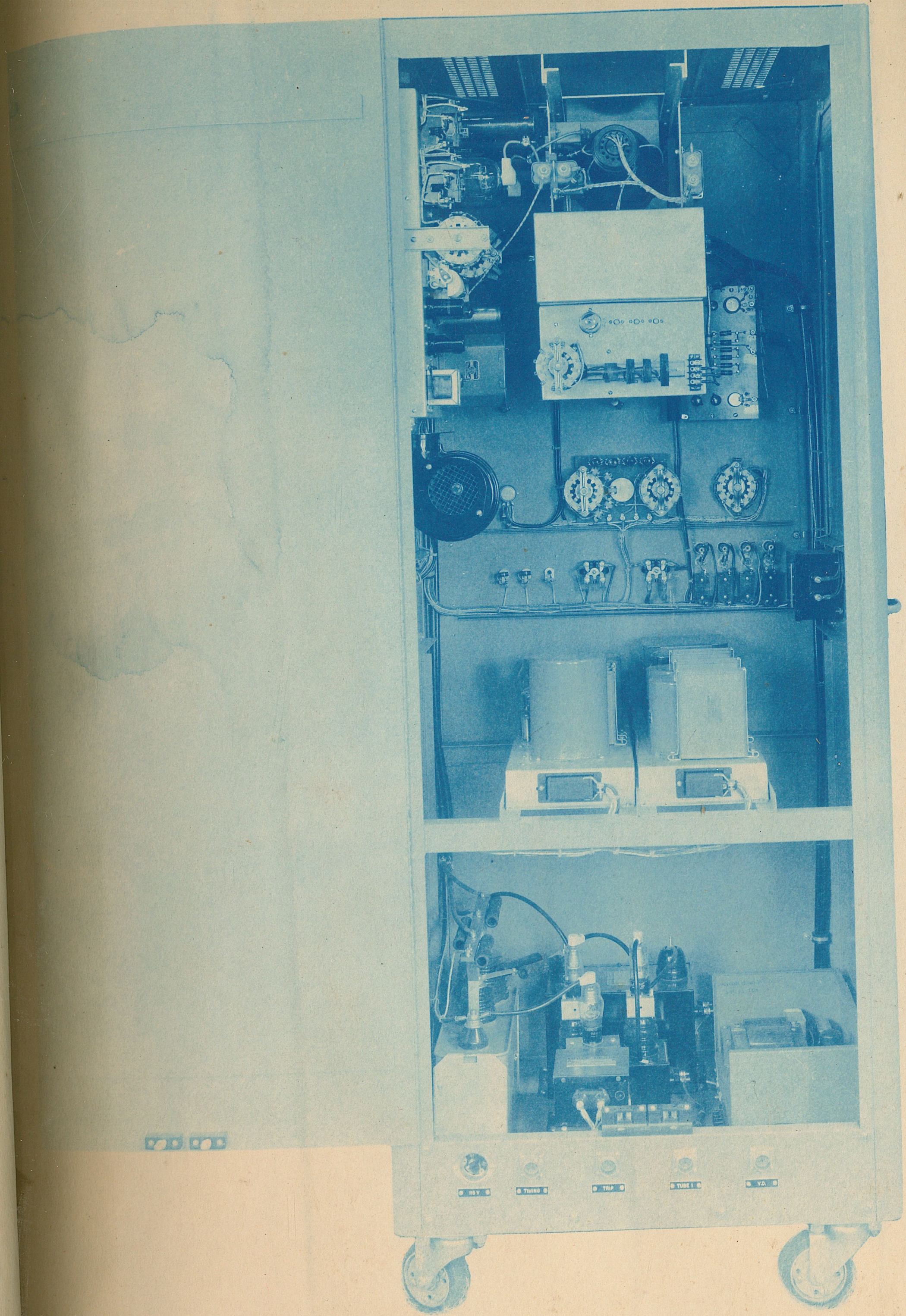
1. Always be sure that oscillograph cabinet is grounded before operating
2. Use fuses of the sizes engraved on marker plates to get adequate protection
3. If any work is to be done on the 25KV supply, its capacitor bushings should be grounded to take off any residual charge. This should be done after allowing about 15 seconds for the charges to leak off thru the resistance divider.



1081 809 G-E CATHODE-RAY OSCILLOGRAPH, TYPE HC-25-C1. REAR DOOR OPEN. REAR VIEW.

5-5-50

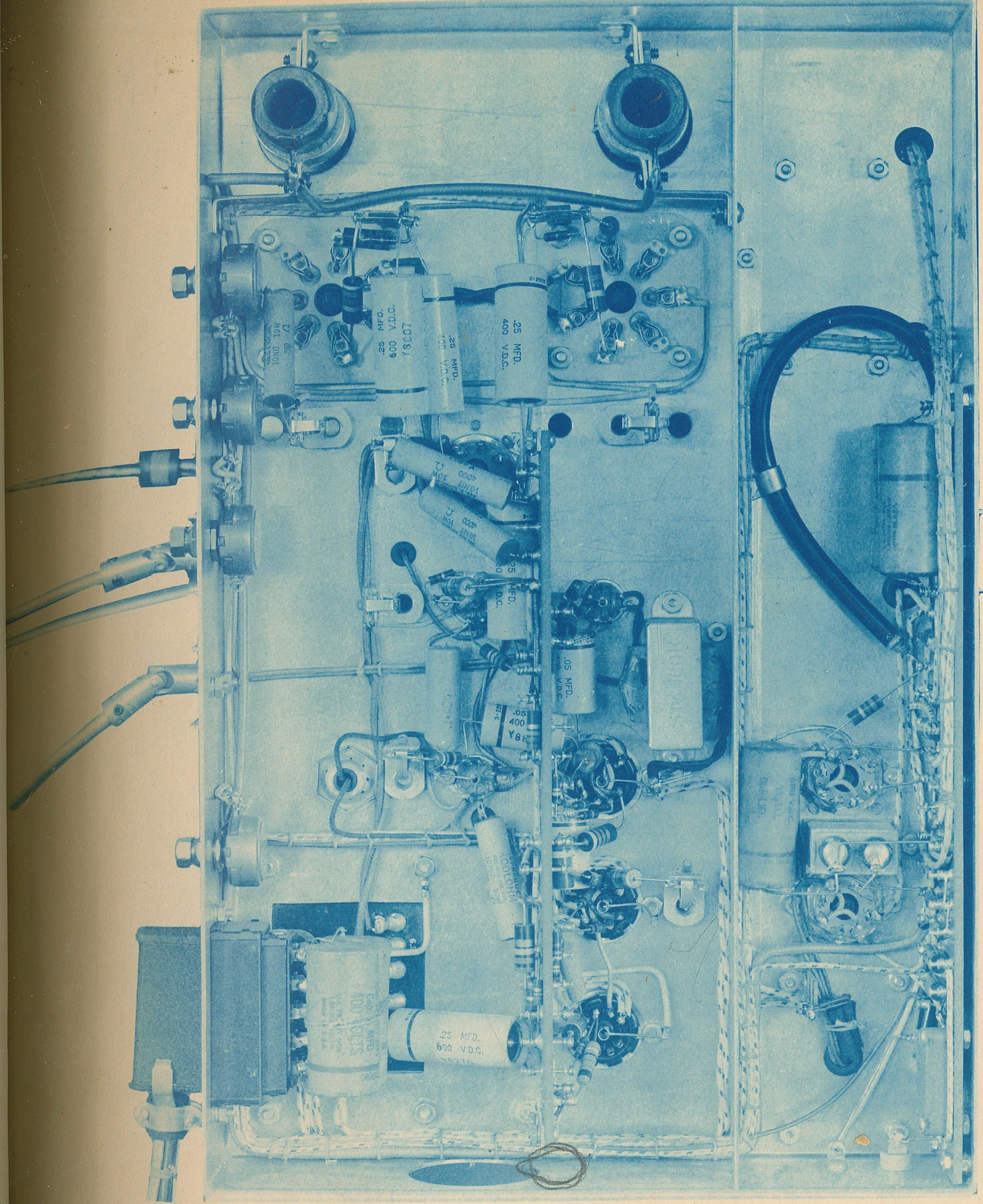
F369.1



1081 810 G-E CATHODE-RAY OSCILLOGRAPH, TYPE HC-25-C1. SIDE VIEW SHOWING INTERIOR.

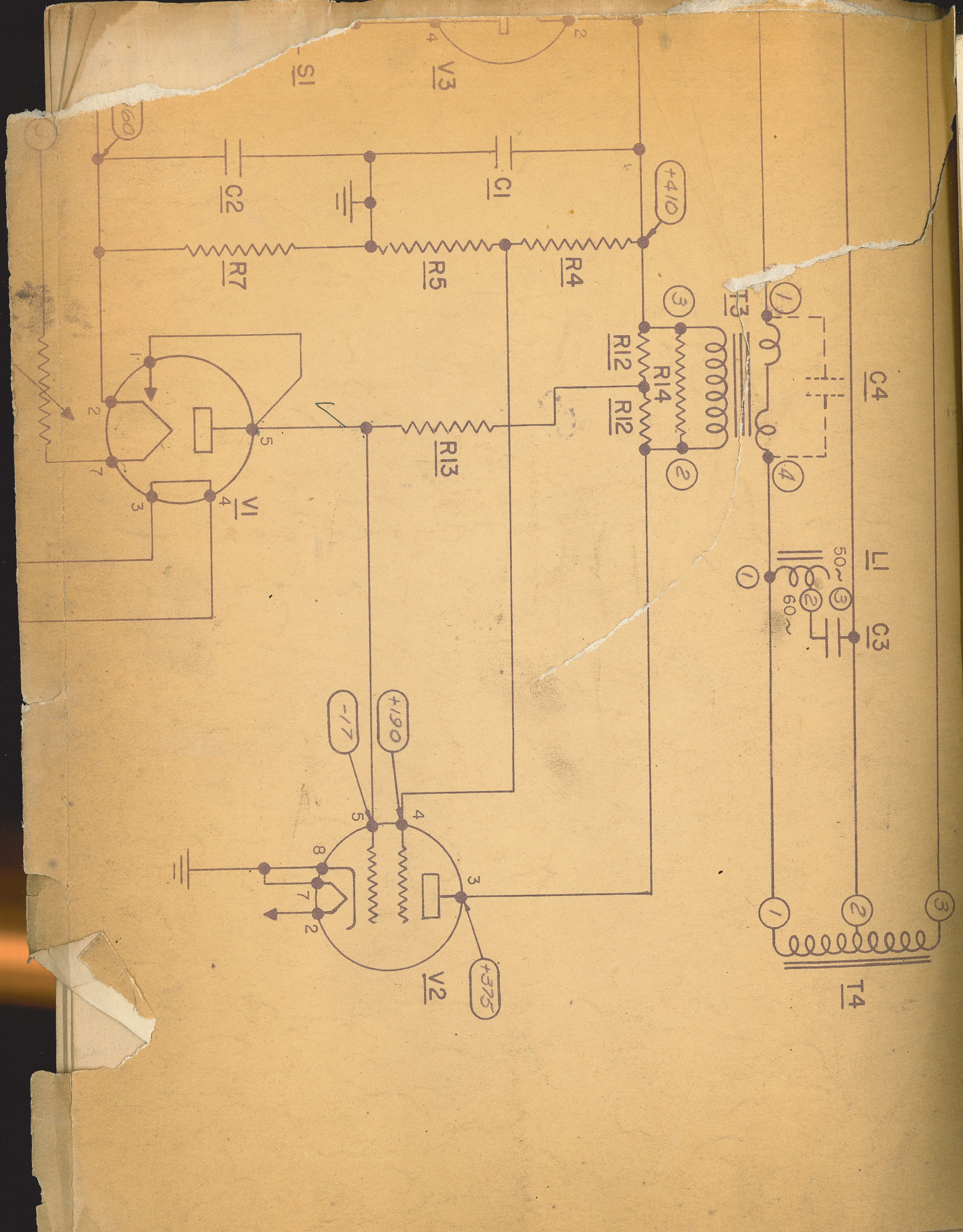
E369.1

5-5-50

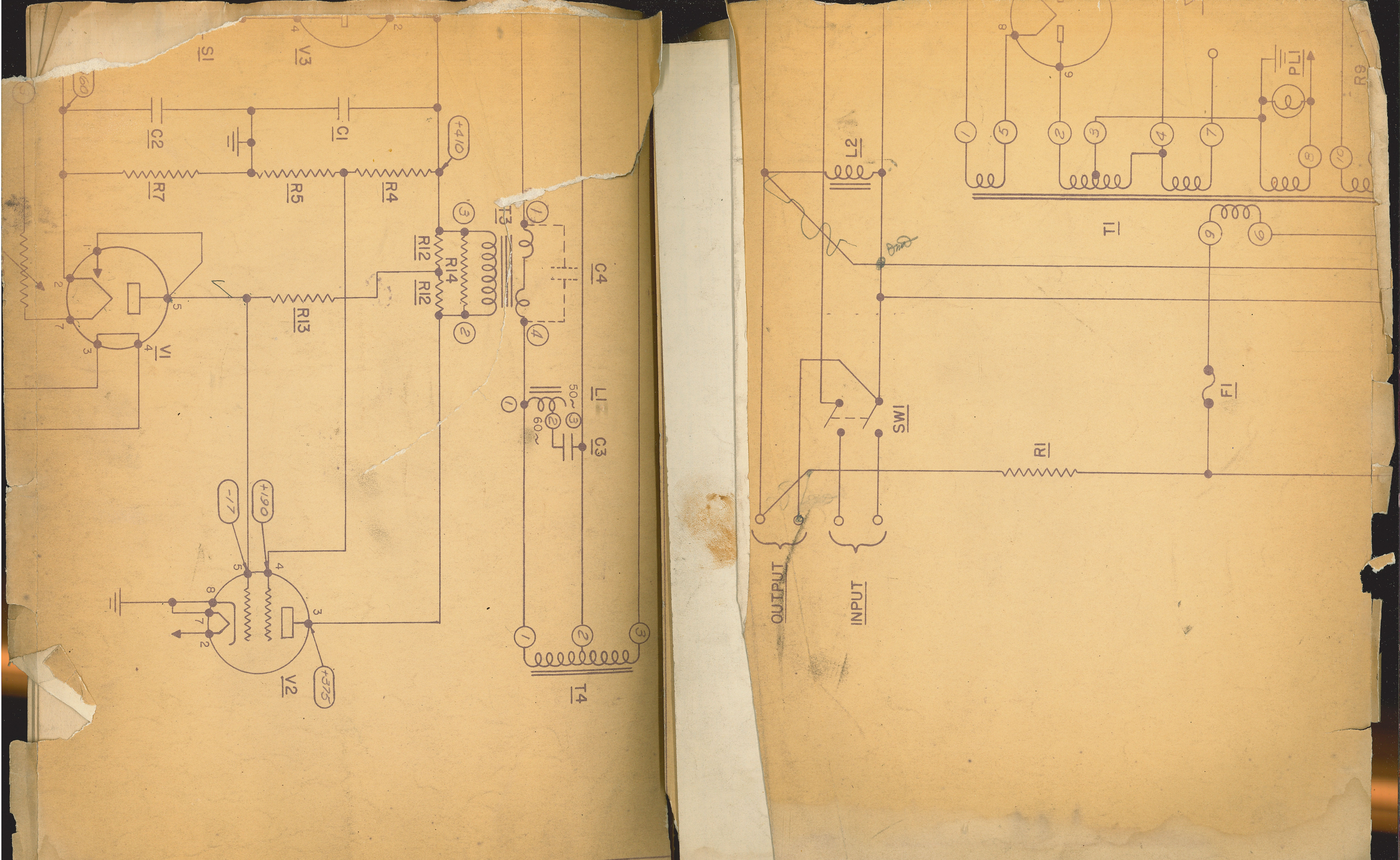


1081 811 G-E CATHODE-RAY OSCILLOGRAPH, TYPE HC-25-C1. FRONT VIEW OBLIQUE FROM LEFT.

E369.1 5-5-50



SD 200-09
DRAWING NUMBER



SD 200-09
DRAWING NUMBER

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
R12	27K Ω 2W	T1	POWER TRANS. 816	V1	2AS15
R13	4.7 MEG. Ω 1W	T2	COMP. TRANS. 904	V2	6L6
R14	25K Ω 10W	T3	SAT. CORE REACTOR 1175 A.C. 1174 D.C.	V3	5Y3
		T4	AUTO TRANS. 205		
C1	8 MFD. 500 VDC ELECT.			F1	FUSE 1 AMP 3AG
C2	0.1 MFD. 1000V				
C3	4 MFD. 600V	L1	3RD. HAR. CHOKE 1093	SW1	SWITCH DPST
C4	* 0-1 MFD. 600V	L2	LOADING CHOKE 744		
				PL1	PILOT LIGHT
				S1	SEL. RECT. SE 8L32H

* ADDED IN TEST AS NECESSARY

ENCIRCLED VALUES ARE NORMAL D.C. POTENTIALS TO GROUND (CHASSIS) AT 115 V.A.C. INPUT, 115 V.A.C. OUTPUT, AND HALF LOAD

SERIAL NO. ________ TO SERIAL NO. ________

SORENSEN & CO., INC.
STAMFORD, CONN.

SCHEMATIC DIAG.

MODEL 500

MAT'L.	
FINISH	
SCALE	

PVE	3-7-50	GH	3-14-50
DRAWN BY	DATE	ELEC. DESIGN APPR. BY	DATE
[illegible]	3-14-50		
CHECKED BY	DATE	APPROVED BY	DATE

SD 200-093
DRAWING NUMBER

ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION	ITEM	DESCRIPTION
R1	VOLTAGE COMP.	R12	27KΩ 2W	T1	POWER TRANS. 816	V1	2AS15
R2	10KΩ 1/2W	R13	4.7 MEG. Ω 1W	T2	COMP. TRANS 904	V2	6L6
R3		R14	25KΩ 10W	T3	SAT. CORE REACTOR 1175 A.C. 1174 D.C.	V3	5Y3
R4	10KΩ } 35,000Ω TAPPED AT			T4	AUTO TRANS 205		
R5	25KΩ } 10KΩ 20W	C1	8 MFD. 500 VDC ELECT.			F1	FUSE 1 AMP 3AG
R6		C2	0.1 MFD. 1000V				
R7	1.8 MEG 1W	C3	4 MFD. 600V	L1	3RD. HAR. CHOKE 1093	SW1	SWITCH DPST
R8	DIODE ADJUST.	C4	*0-1 MFD. 600V	L2	LOADING CHOKE 744		
R9	1Ω 3 W POT.					PL1	PILOT LIGHT
						S1	SEL. RECT. 5E 8L32H

TOLERANCES ON DIMENSIONS NOT OTHERWISE SPECIFIED

DECI. DIM. FRAC. DIM. ANG. DIM.

REV. LET.
REV. ITEM
REVISION
DATE
DRAFTSMAN
CHECKED BY
APPROVED BY

GENERAL ELECTRIC

M-5113137

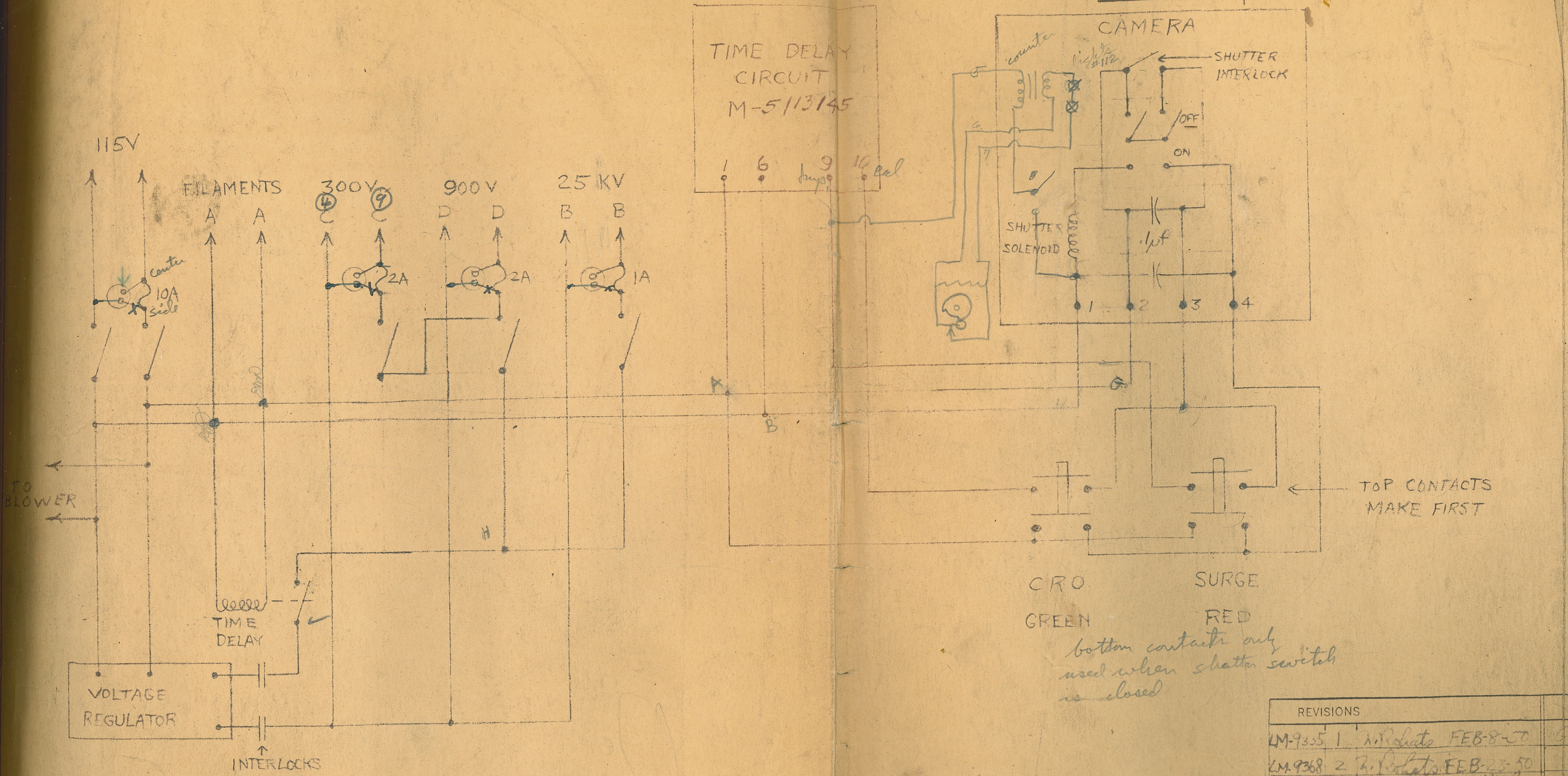
CONT ON SHEET SH NO.

REV NO.

CONT ON SHEET SH NO.

TITLE 115 VOLT CIRCUITS

FIRST MADE FOR HC-25-C1 CATHODE RAY OSCILLOGRAPH



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LM-9368	2	[illegible]	FEB-23-50	
LM-	3	P. Maure	[illegible] 1950	

MADE BY [illegible] 2-50

ISSUED Jan 31.50

APPROVALS

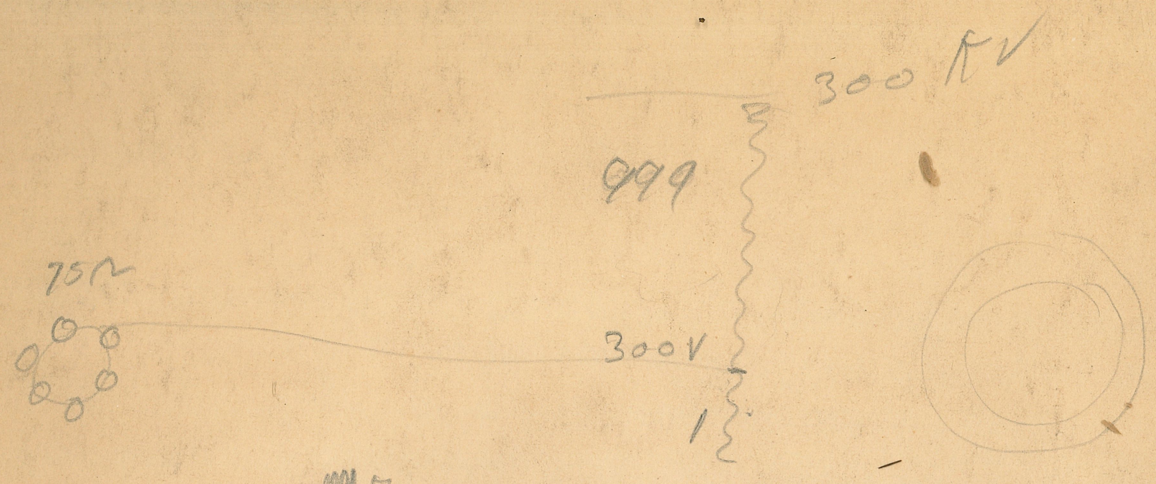
GENERAL ENG LAB DIV

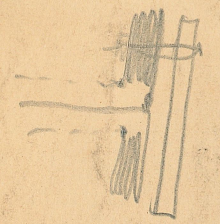
SCHENECTADY WORKS

M-5113137

CONT ON SHEET SH NO.

SKETCH





.0012
5000)6000
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75
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Hi Volt Circuits

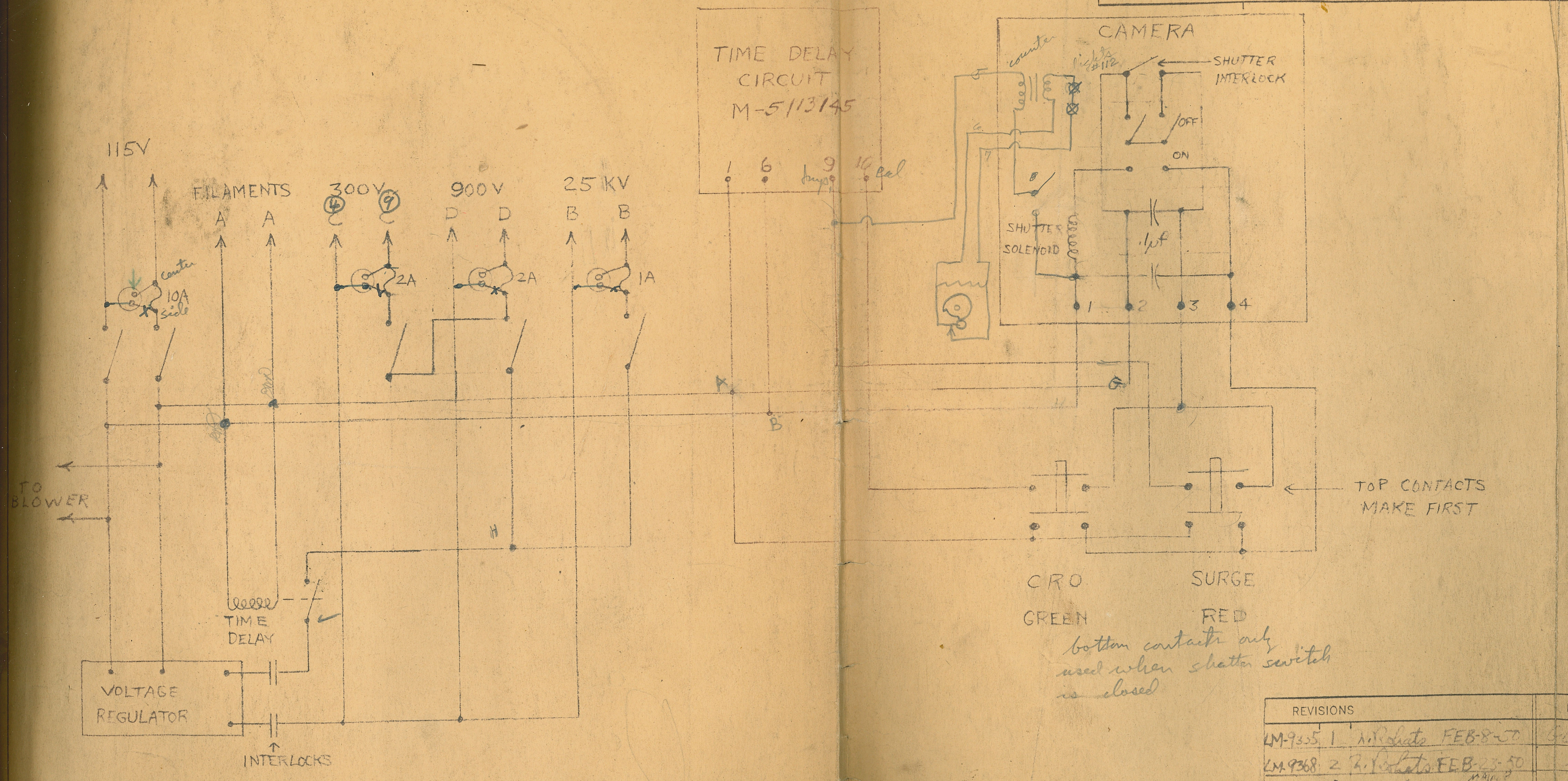
GENERAL ELECTRIC

M-5113137

TITLE 115 VOLT CIRCUITS

FIRST MADE FOR HC-25-C1 CATHODE RAY OSCILLOGRAPH

REV NO. | CONT ON SHEET | SH NO.



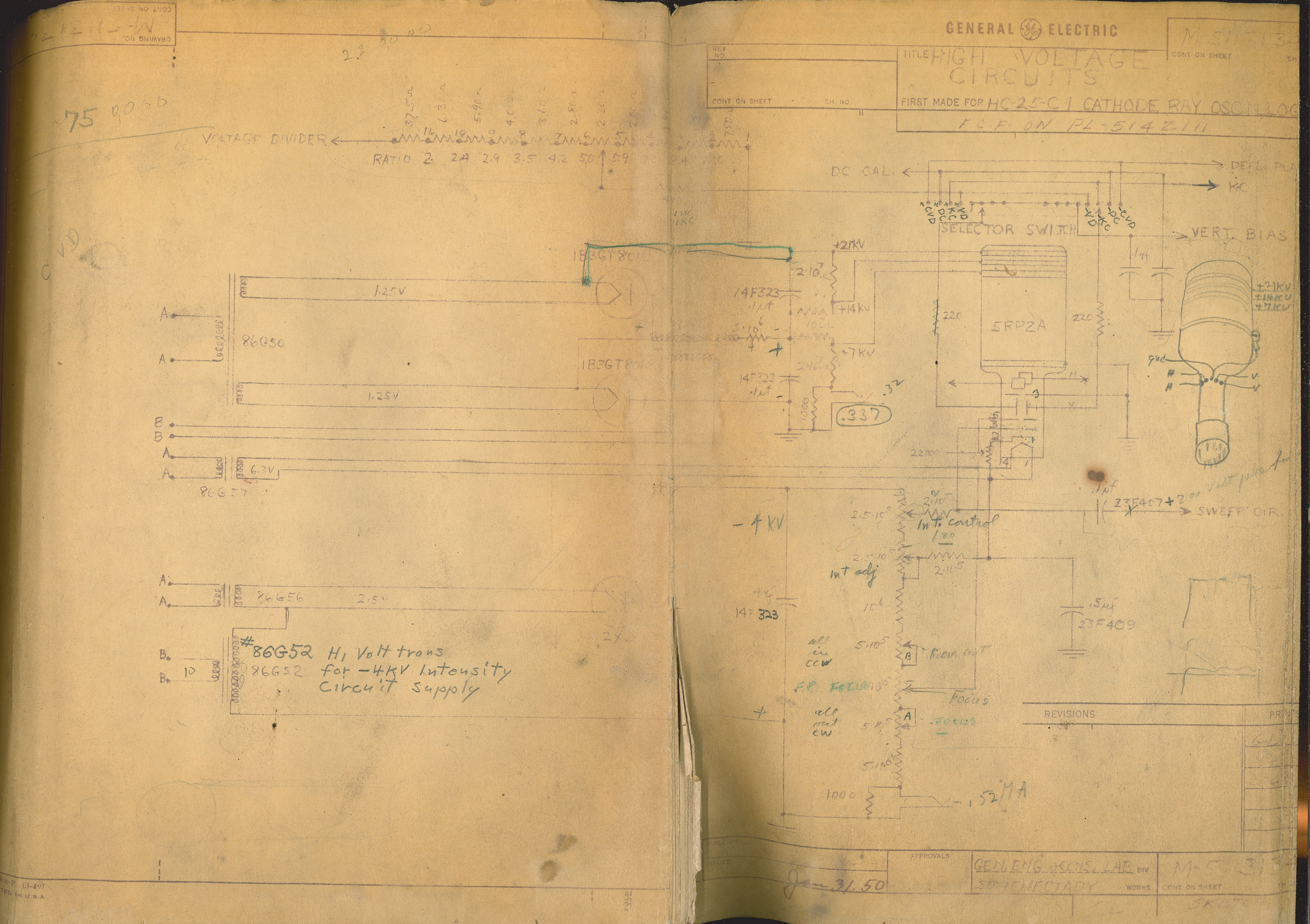
REVISIONS			PRINTS TO
LM-9335	1	FEB-8-50	
LM-9368	2	FEB-23-50	
LM-	3	P. Maure 1950	

MADE BY	APPROVALS		
2-50		GENERAL ENG LAB DIV	M-5113137
ISSUED Jan 31-50		SCHENECTADY WORKS	CONT ON SHEET / SH NO.

SKETCH

DRAWING NO. M-5113137 CONT ON SHEET SH NO.

FF-806-P (3-49) PRINTED IN U.S.A.


GENERAL ELECTRIC
TITLE HIGH VOLTAGE CIRCUITS
FIRST MADE FOR HC-25-C1 CATHODE RAY OSCILLOG
F.E.F. ON PL-514211
CONT ON SHEET
SH. NO.
REV NO.
DRAWING NO.
VOLTAGE DIVIDER
RATIO 2 2.4 2.9 3.5 4.2 5.0 5.9
DC CAL.
DEFL. PL
KC
SELECTOR SWITCH
VERT. BIAS
+21KV
+14KV
+7KV
1B3GT8016
1.25V
86G50
14F323
5RP2A
220
.337
6.3V
86G57
-4KV
Int. control
Int adj
2.5V
86G56
#86G52 Hi Volt trans
86G52 for -4KV Intensity
Circuit supply
14F323
.5μf
23F409
23F407
SWEEP CIR.
all in ccw
all out cw
Focus
.52MA
1000
REVISIONS
APPROVALS
GEN. ENG. & CONS. LAB DIV
SCHENECTADY WORKS
Jan 31.50
PRINTED IN U.S.A.

46

146 H NO.

OGRA

R PLUG

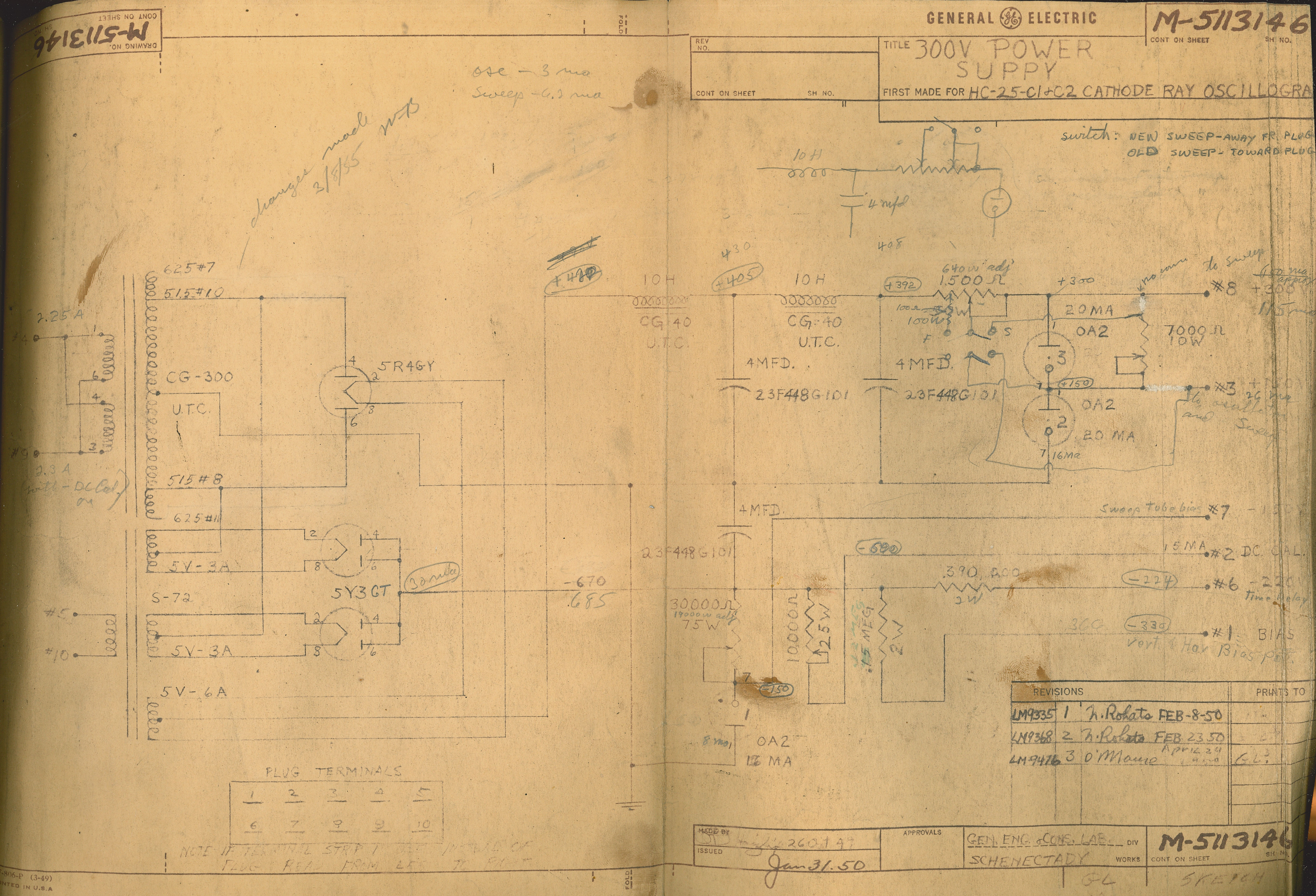
D PLUG

TO

300 V supply

FF-806-P

PRINTED IN



GENERAL ELECTRIC
M-5113146
CONT ON SHEET
SH NO.
REV NO.
TITLE 300V POWER SUPPY
FIRST MADE FOR HC-25-C1+C2 CATHODE RAY OSCILLOGRA
DRAWING NO. M-5113146
osc - 3 ma
Sweep - 6.3 ma
changes made 3/8/55
switch: NEW SWEEP-AWAY FR. PLUG
OLD SWEEP-TOWARD PLUG
10 H
4 mfd
625 #7
515 #10
2.25 A
#4
CG-300
U.T.C.
#9
2.3 A
515 #8
625 #11
5R4GY
5V-3A
5Y3GT
S-72
#5
#10
5V-3A
5V-6A
+430
10 H
CG-40
U.T.C.
+405
4 MFD.
23F448G101
640 w adj
1,500 Ω
+392
+300
20 MA
OA2
7000 Ω
10 W
#8
+300
+150
#3
+150
OA2
20 MA
16 ma
4 MFD.
Sweep tube bias #7
23F448G101
-690
15 MA #2 DC CAL.
-670
.685
390,000
2 W
-224
#6
-220
time delay
30,000 Ω
75 W
10,000 Ω
25 W
.15 MEG
2 W
-330
#1 BIAS
Vert & Hor Bias pot.
+150
OA2
16 MA
8 ma
PLUG TERMINALS
1 2 3 4 5
6 7 8 9 10
REVISIONS
PRINTS TO
LM9335 1 H. Rohats FEB-8-50
LM9368 2 H. Rohats FEB 23 50
LM9476 3 O'Mane April 24
MADE BY
ISSUED
Jan 31.50
APPROVALS
GEN. ENG. & CONS. LAB.
DIV
SCHENECTADY
WORKS
M-5113146
SKETCH
PRINTED IN U.S.A.

.017

$$\begin{array}{r} 17 \\ 17 \\ \hline 119 \\ 17 \\ \hline 289 \end{array}$$

$$\begin{array}{r} 17 \\ 16 \\ \hline 102 \\ 17 \\ \hline 272 \end{array}$$

(17×10^{-3})

$.289 \times 10^{-3} + 16 \times \cancel{10^{-7}}$

$= 4.620 \times 10^{-7}$

900 Volt P.S.

M-5113147

$9 \times 10^{-2} \times 9 \times 10^{-2} = 81 \times 10^{-4}$

$81 \times 10^{-4} \times 9 \times 10^{4}$

GENERAL ELECTRIC

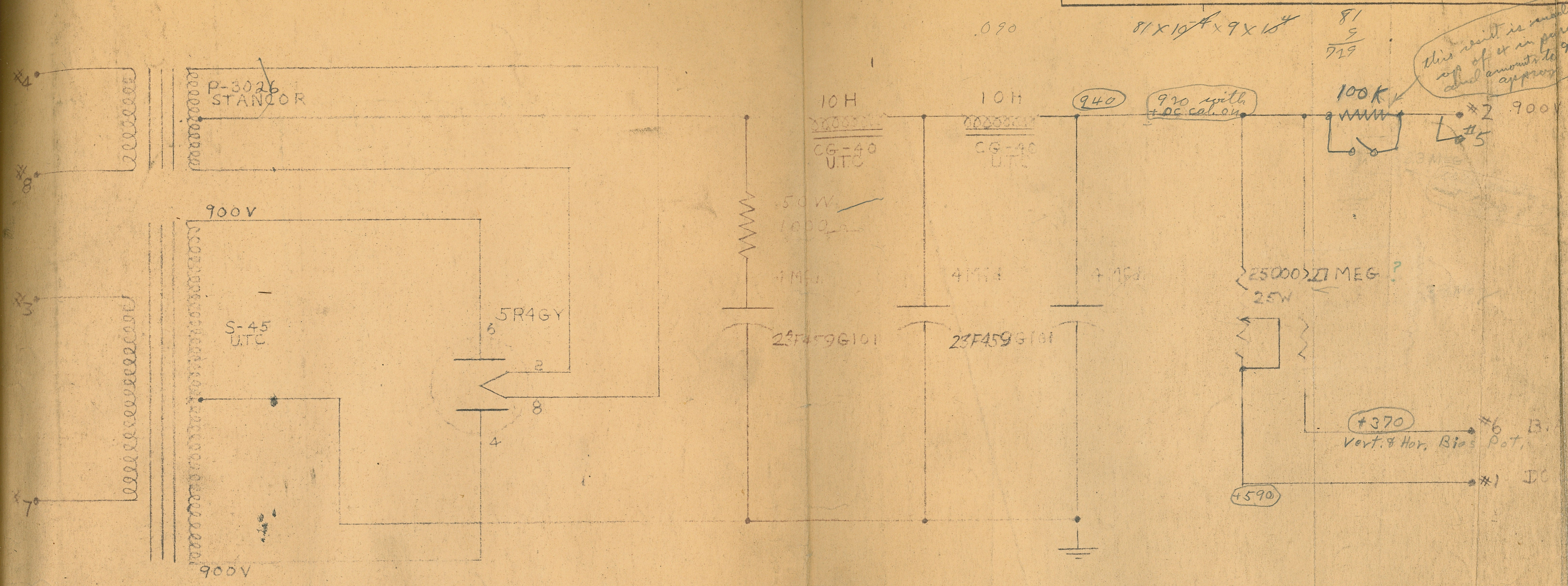
REV NO. | CONT ON SHEET | SH NO.

TITLE 900 VOLT POWER SUPPLY

FIRST MADE FOR HC-25-C1+C2 CATHODE RAY OSCILLOGRAPH

M-5113147

CONT ON SHEET | SH NO.



PLUG TERMINALS

1	2	3	4
5	6	7	8

NOTE: IF TERMINAL STRIP IS USED INSTEAD OF PLUG READ FROM LEFT TO RIGHT

REVISIONS			PRINTS TO
LM9335	1	N. Rohats FEB 8-50	R
LM9368	2	N. Rohats FEB 23-50	GL3
LM9476	3	D. Moore APRIL 24 50	5-23

MADE BY

ISSUED Jan 31. 50

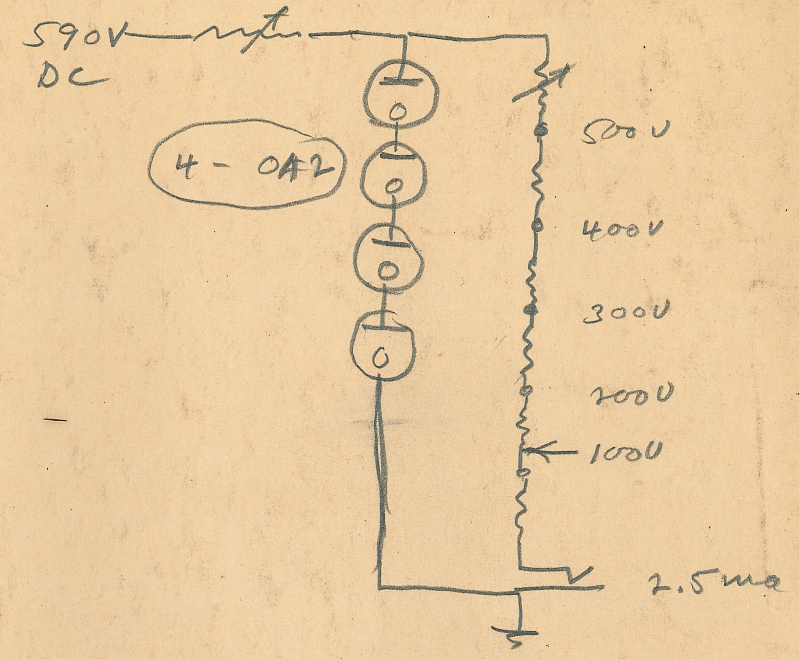
APPROVALS

GEN ENG. & CONS. LAB DIV

SCHENECTADY WORKS

M-5113147

CONT ON SHEET | SH NO.



Calibrating Circuit

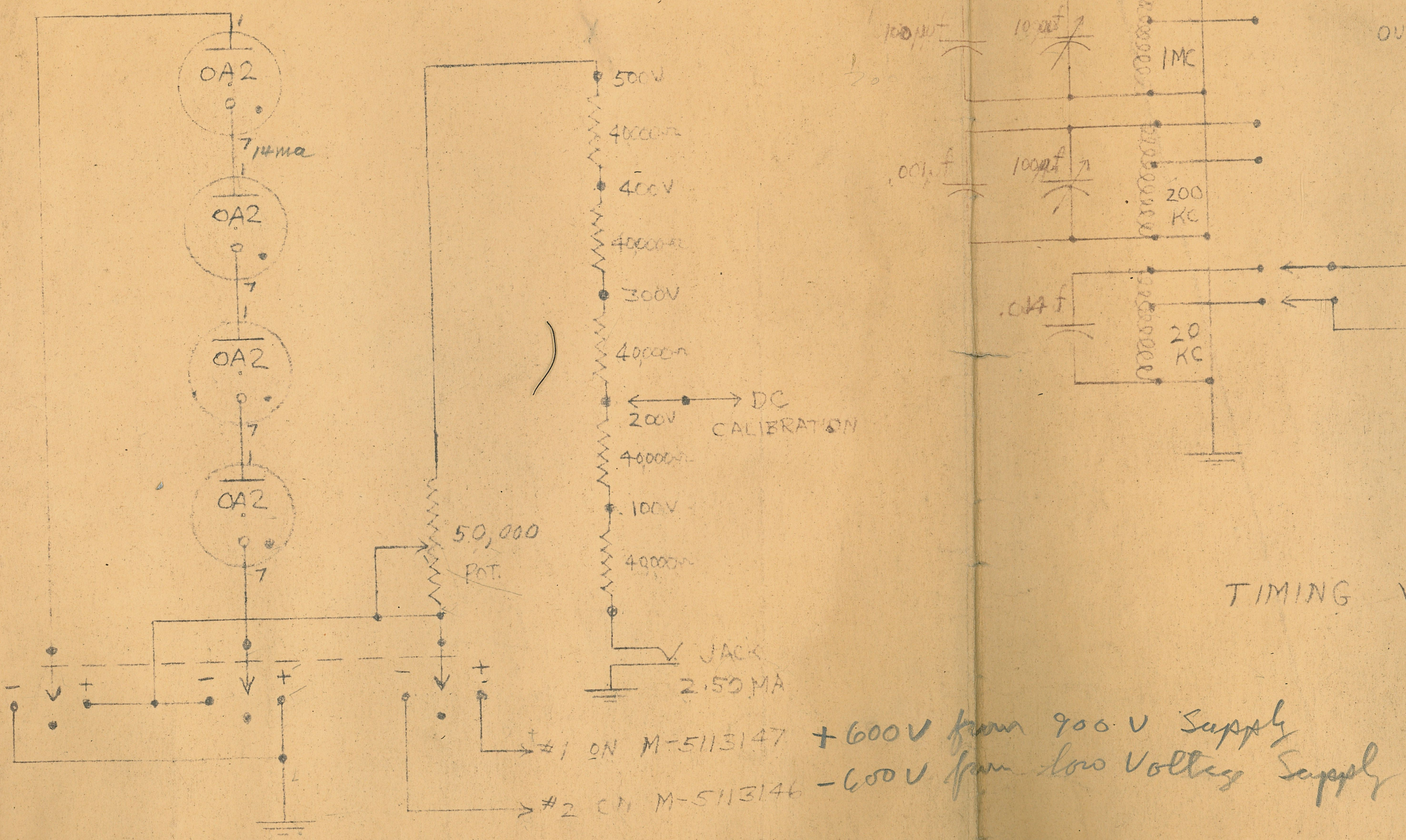
TITLE CALIBRATION CIRCUITS

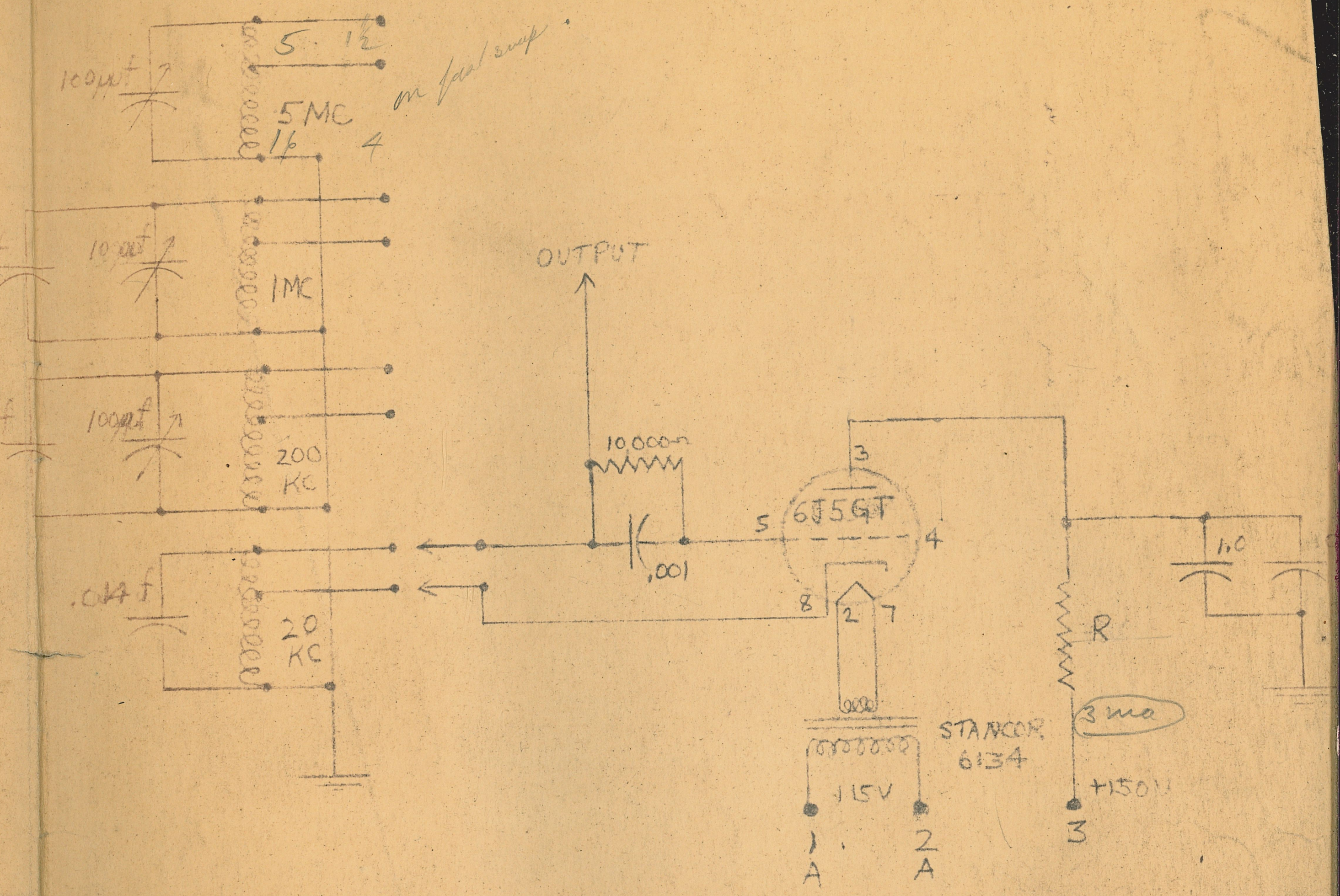
FIRST MADE FOR HC-25-C1 C2 CATHODE RAY OSCIL

REV NO.

CONT ON SHEET 1 SH NO.

DC.CALIBRATION CIRCUIT





TIMING WAVE OSCILLATOR

REVISIONS			PRINT
LM-9384	1	R. Rohato Mar 8-50	
LM 9476	2	D. Moure April 24 1950	

MADE BY Feb 1-50

TRACED Feb 8-50

APPROVALS

GEN. ENG. & CONS. LAB. DIV

SCHENECTADY WORKS

F-806-P (3-49)
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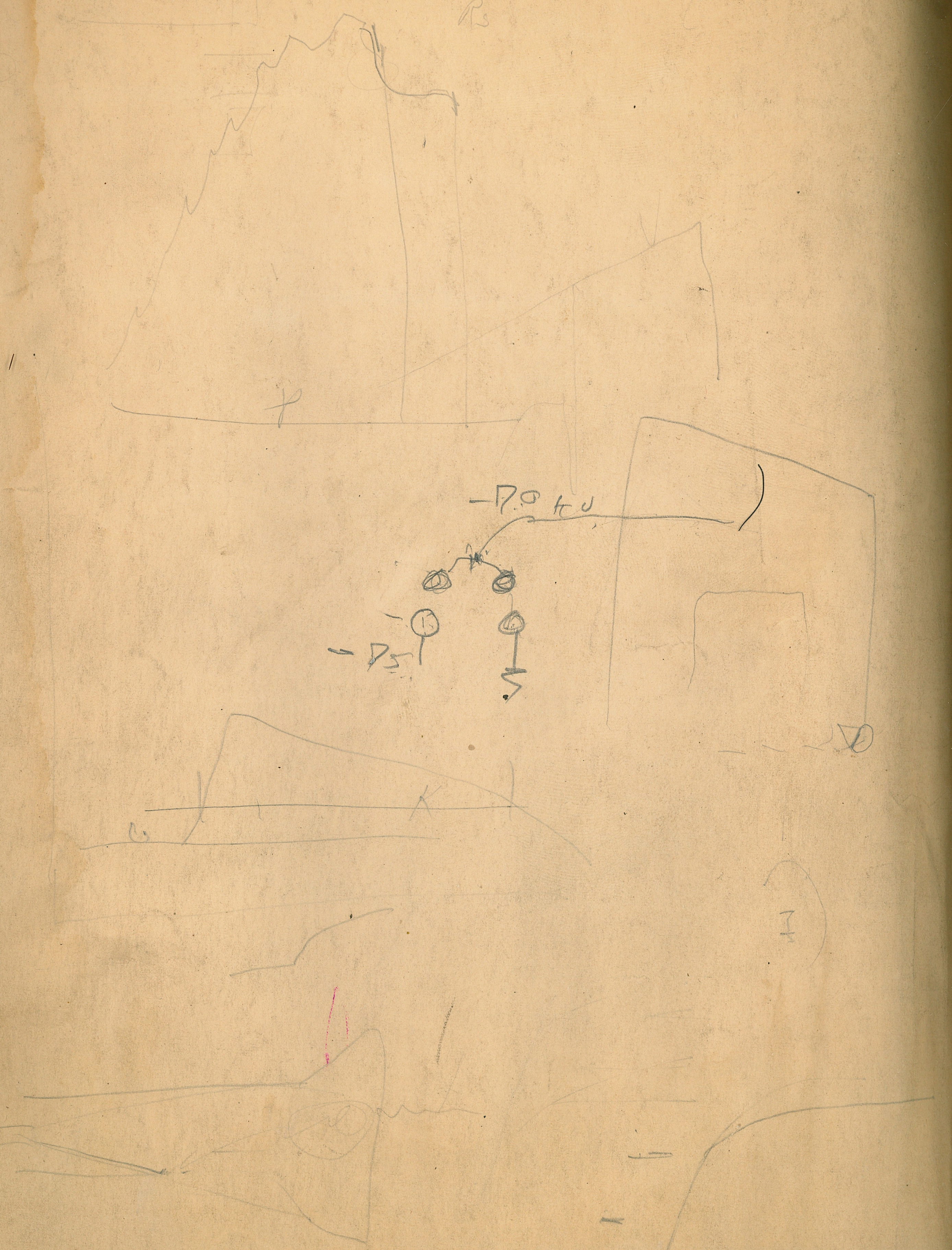
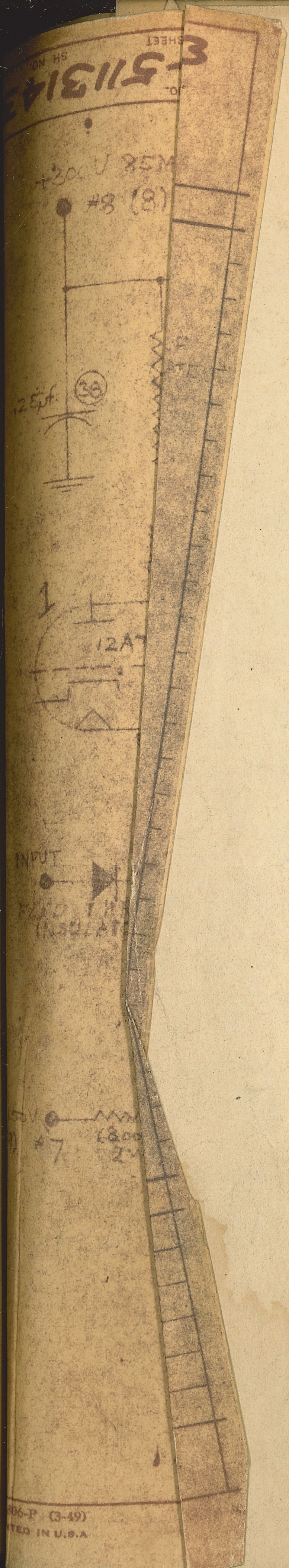




SWEEP

GENERAL ELECTRIC

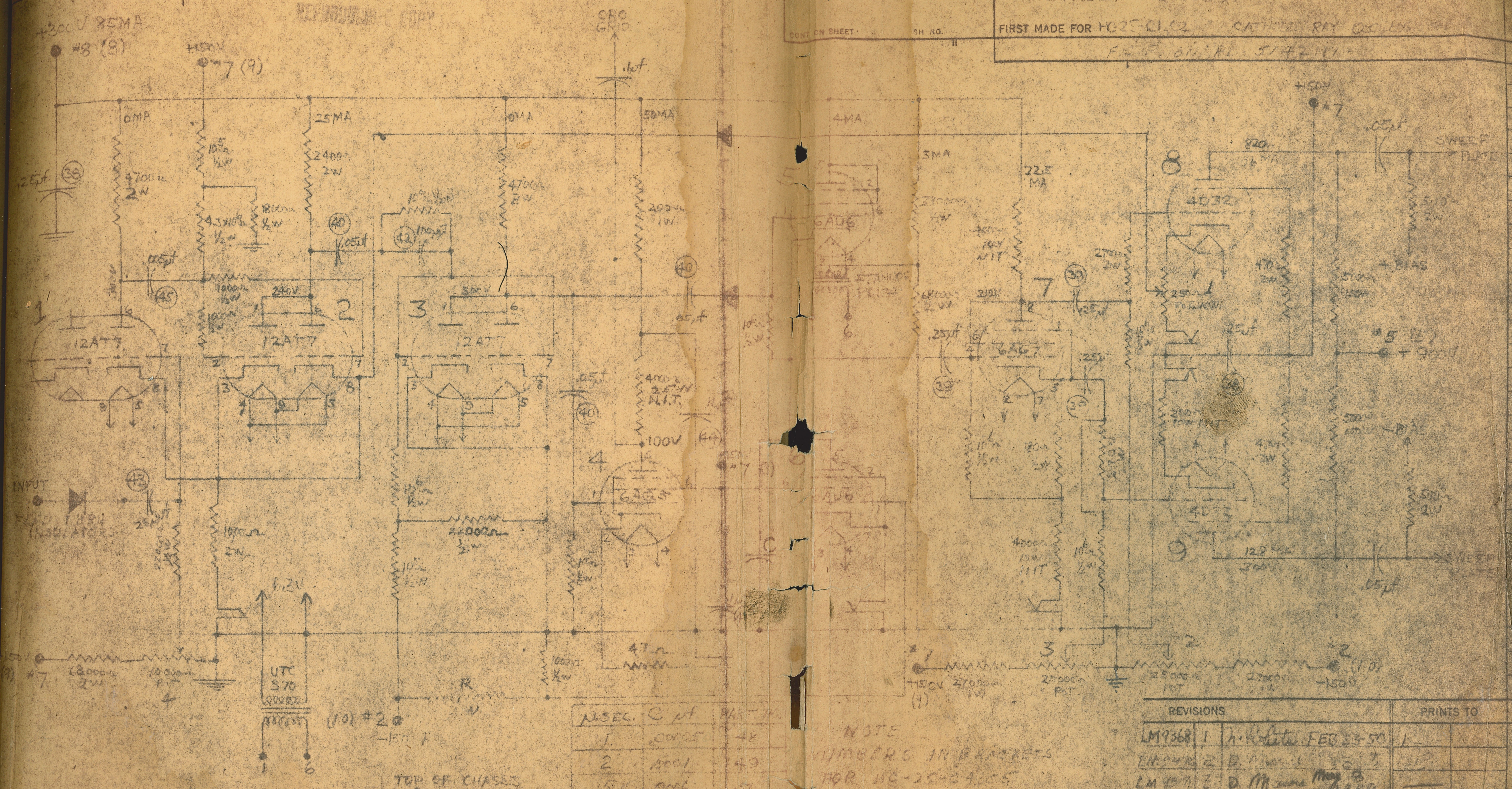
M-5113143

CONT ON SHEET SH NO.

TITLE SWEEP CIRCUIT

FIRST MADE FOR HC-25-C1, C2 CATHODE RAY OSCILLOS...

F.2 P. ON RL 5142...



μSEC.	C μf	PART NO.
1	.00005	48
2	.0001	49
5	.0006	50
15	.0016	67+50
35	.004	52
70	.008	52+52
250	.03	51
1000	.12	41+

PLUG TERMINALS

TOP OF CHASSIS

1	2	3	4	5
6	7	8	9	10

NOTE - IF TERMINAL STRIP IS USED INSTEAD OF PLUG READ FROM LEFT TO RIGHT

NOTE
NUMBERS IN BRACKETS FOR HC-25C2 ONLY

REVISIONS

LM9368	1	FEB 23-50
LM	2	
LM	3	May 8 - 50
LM1029	4	

PRINTS TO

MADE BY Feb 7-50

APPROVALS

GEN. ENG. ... DIV

SCHENECTADY WORKS

M-5113143

CONT ON SHEET SH NO.

New – 1N34 reads 500,000 Ω forward / 500 Ω reverse

.100
.012
.108

2500 Ω

51,000,000

100

$\frac{118}{18} = \frac{150}{x}$

x =

69,000

23.3

3 | 70

x 30

$\frac{122}{22} = \frac{150}{x}$

x =

900
90

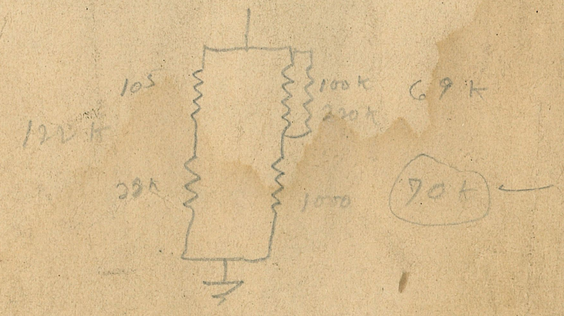
50

10

20K 120K 50K 70K

100,000
220,000

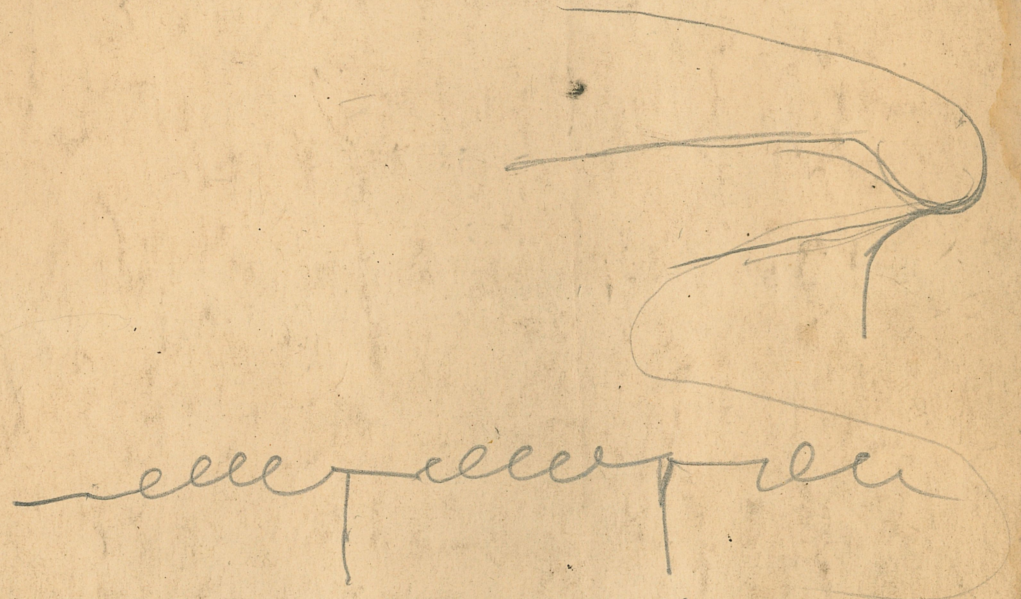
$\frac{10 \times 22}{32}$



$\frac{122 \times 90}{192K}$

44.5K

3143
SH NO.



Sweep Circuit

GENERAL ELECTRIC

M-5113

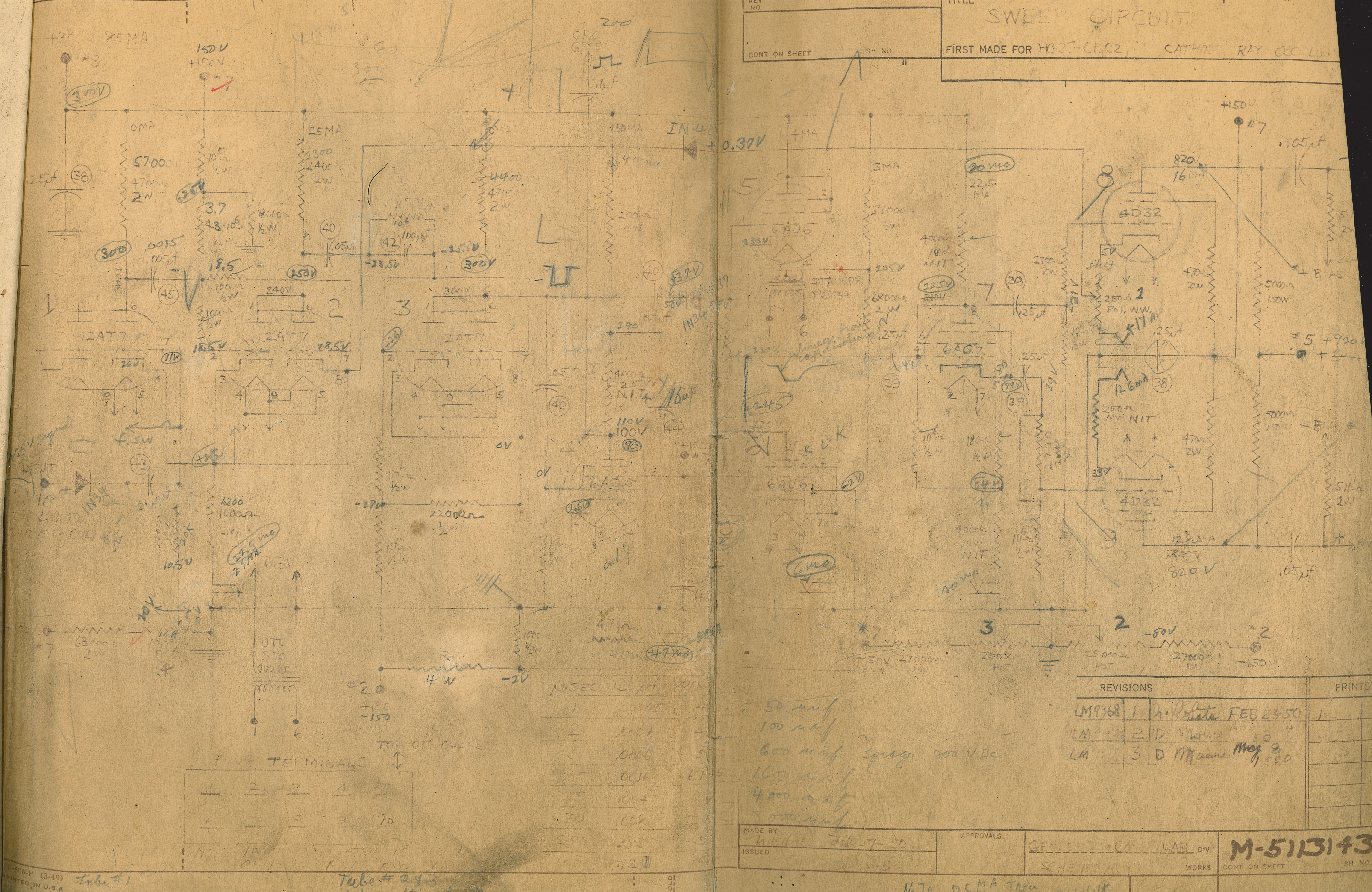
CONT ON SHEET

REV NO.

CONT ON SHEET SH NO.

TITLE SWEEP CIRCUIT

FIRST MADE FOR HG35-CL.C2 CATHODE RAY OSC.



REVISIONS				PRINTS TO
LM9368	1	N. Hiller	FEB 23 50	1
LM	2	D Mann		
LM	3	D Mann	May 8 50	

MADE BY
ISSUED
APPROVALS

GENERAL ENGINEERING LAB DIV
SCHENECTADY WORKS

M-5113143
CONT ON SHEET SH NO.

$T = RC$

range of delay

$2.7 \times 10^4 \times 3 \times 10^{-10} = 8.1 \times 10^{-5} = 0 - .000081$

$4.8 \times 10^4 \times 3 \times 10^{-10} = 5.4 \times 10 = 0$ to $.000054$

$3.3 \times 10^4 \times 3 \times 10^{-10} = 9.9 \times 10 = 0$ to $.000099$

$1.2 \times 10^5 \times 3 \times 10^{-10} = 3.6 \times 10^2 = 0$ to $.00036$

$3.3 \times 10^5 \times 3 \times 10^{-10} = 9.9 \times 10^2 = 0$ to $.00099$

$4.7 \times 10^5 \times 3 \times 10^{-10} = 1.41 \times 10^3 = 0$ to $.001410$

$2.2 \times 10^6 \times 3 \times 10^{-10} = 6.6 \times 10^3 = 0$ to $.0066$

$4.7 \times 10^6 \times 3 \times 10^{-10} = 1.41 \times 10^4 = 0$ to $.014$

.0003 0 3×10^{-9} & 27

$$\frac{27 \times 50}{77} = 17.5$$

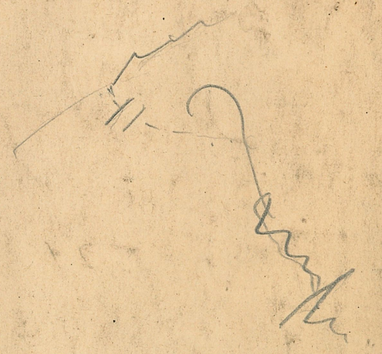
$$\frac{27 \times 55}{82} =$$

100,000
56,000
56,000
212,000

$$\frac{2.5 \times 10^5}{2.12 \times 10^5}$$

$X_L = 2\pi f h \times 10^{-6}\ \Omega$

$X_C = \frac{10^{12}}{2\pi f C} = \Omega$



Time delay

DRAWING NO. M-5113145 CONT ON SHEET

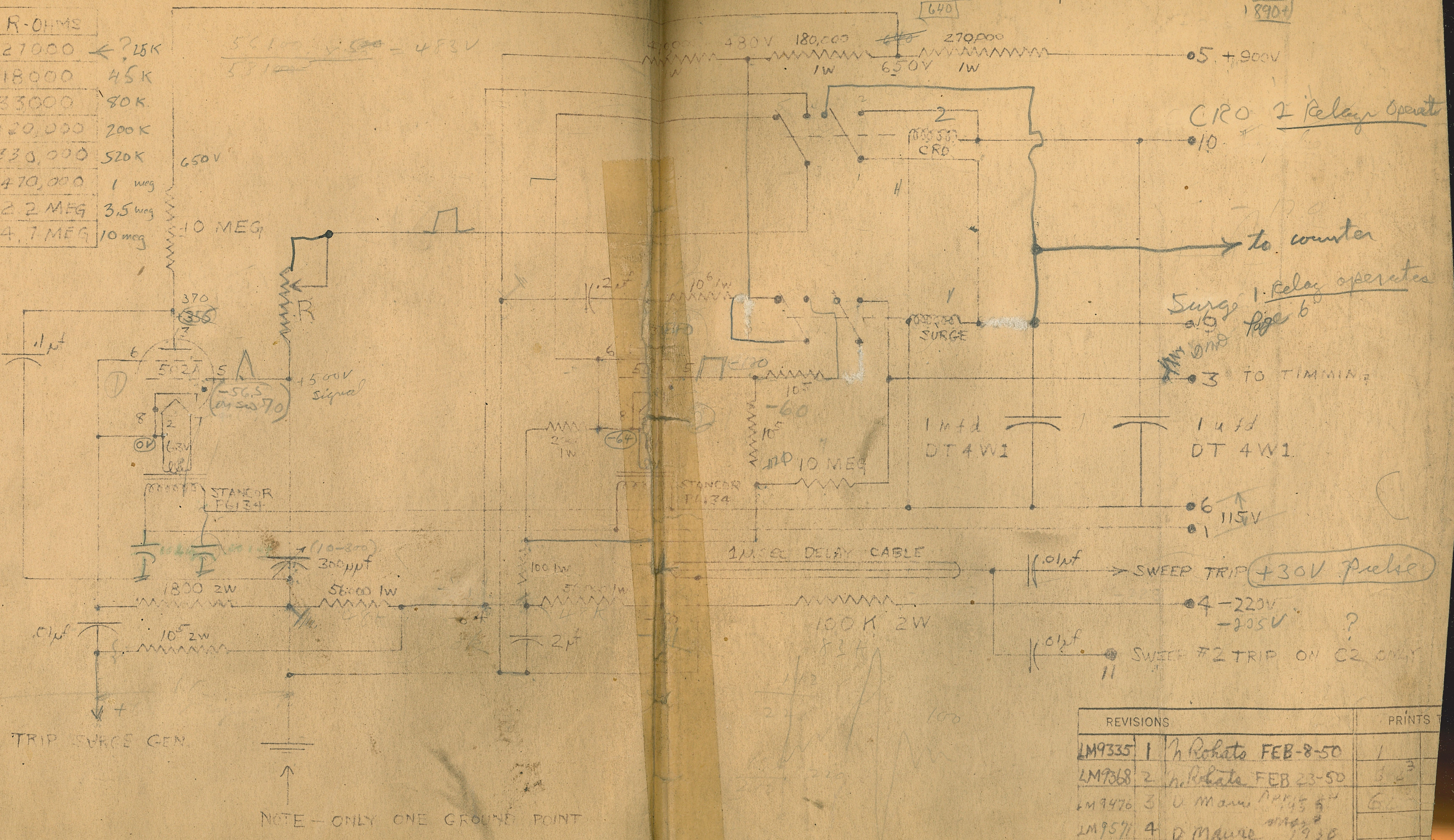
GENERAL ELECTRIC

M-5113145

TITLE: TIME DELAY CIRCUIT

FIRST MADE FOR HC-25-C1 & C2 CATHODE RAY OSCILLOGRAPH

SWEEP MICRO-SEC.	R-OHMS	
1	27000	? 25K
2	18000	45K
5	33000	80K
15	120,000	200K
35	330,000	520K
70	470,000	1 meg
250	2.2 MEG	3.5 meg
1000	4.7 MEG	10 meg



REVISIONS			PRINTS TO
LM9335	1	N. Rohats FEB-8-50	1
LM9368	2	N. Rohats FEB 23-50	1
LM9476	3	D. Maure Apr. 5 1950	6
LM9571	4	D. Maure May 8 1950	

MADE BY N. Rohats JAN 2-50

ISSUED Jan 31.50

APPROVALS

GEN. ENG. & CONS. LAB. DIV

SCHENECTADY WORKS

M-5113145 CONT ON SHEET SH NO.

SH NO. 8140

F-806-P (3-4

PRINTED IN U.S

M-5113140
DRAWING NO. CONT ON SHEET SH NO.

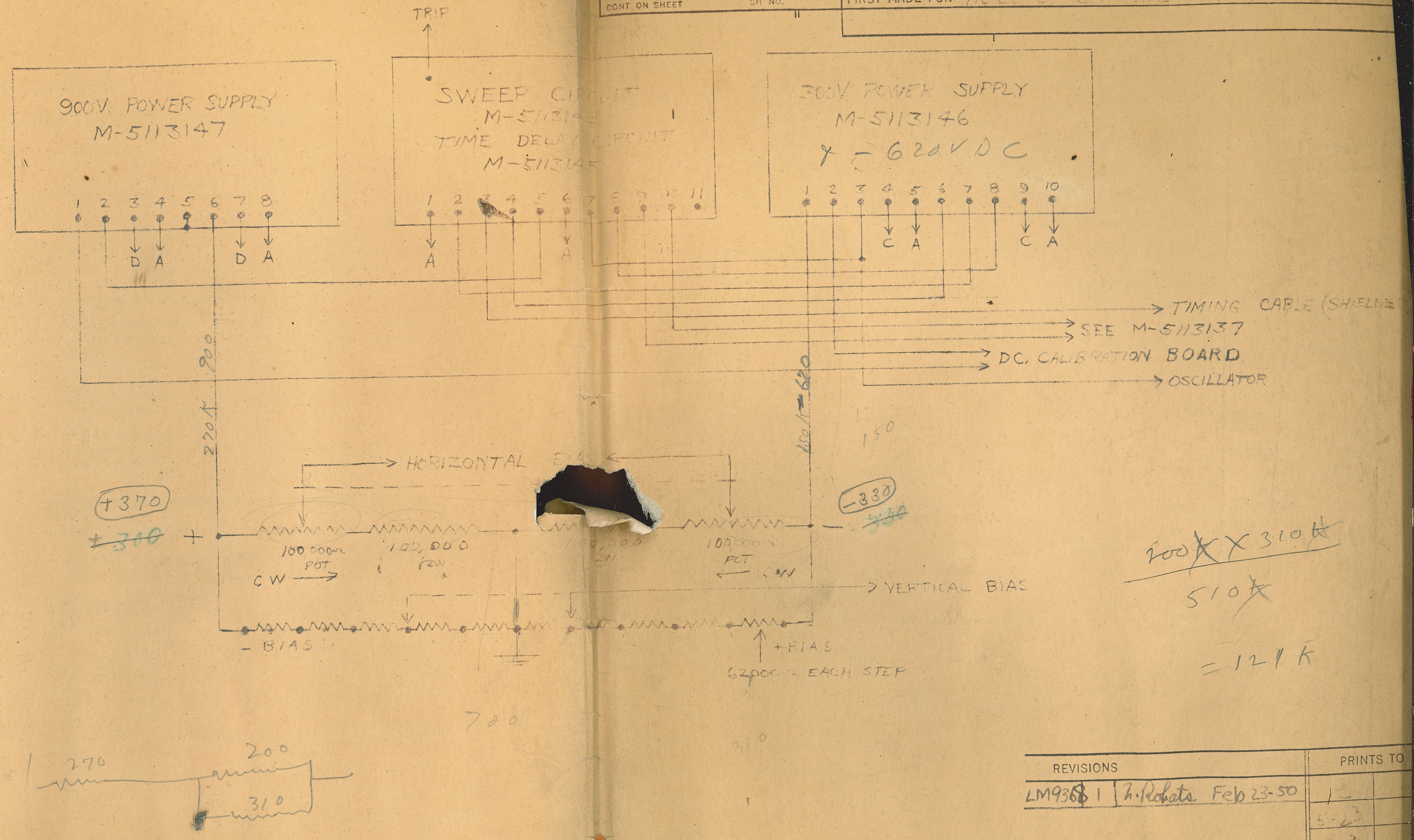
GENERAL ELECTRIC

M-5113140
CONT ON SHEET SH NO.

REV. NO.
CONT ON SHEET SH NO.

TITLE INTERCONNECTIONS

FIRST MADE FOR HC-25-C1 CATHODE RAY OSCILLOGRAPH



REVISIONS			PRINTS TO
LM9368	1	L. Roberts Feb 23-50	

MADE BY
ISSUED
APPROVALS
GENERAL ENGINEERING AND CONSULTING LAB DIV
SCHENECTADY WORKS
M-5113140
CONT ON SHEET SH NO.

F-806-P (3-49)
PRINTED IN U.S.A.

INSTRUCTION MANUAL

FOR USE WITH

SORENSEN

AC LINE REGULATORS AND NOBATRONS

ENERAL INFORMATION

efore you begin to use your new Sorensen instrument, lease read this instruction book very carefully.

he Sorensen Regulator or Nobatron is a precision in-rument. This does not mean that your Sorensen in-rument will not stand rough handling—it will. How uch, will, of course, depend on your own experience d good judgement. You have chosen the Sorensen nit over all other similar types of equipment for any the reasons listed below —

- Wide input range
- Precise regulation accuracy
- Excellent wave form
- Insensitivity to line frequency fluctuations
- Adjustable output voltage
- Fast recovery time

e experience and "know-how" which have made rensen the first line of STANDARD electronic volt-e regulators, stand behind this instrument. If, for any son, difficulties are encountered, notify the factory once . . . DO NOT ATTEMPT ADJUSTMENTS OR RE-IRS WITHOUT FIRST NOTIFYING THE FACTORY. DO T TAMPER WITH ANY OF THE COMPONENTS. UNIN-RUCTED TAMPERING WITH ANY OF THE COMPONENTS LL VOID YOUR GUARANTEE FOR THAT PARTICULAR RT.

quests for information and service

questions concerning the operation or malfunction- of this instrument should be directed to the Service partment, Sorensen & Company, Inc., 375 Fairfield e., Stamford, Connecticut.

ensen & Company, Inc. has adopted a sales and vice policy which is meant to be a protection to you purchaser, and Sorensen & Company, Inc. as supplier.

spect instruments at once for ipping damage

shipments should be inspected by the buyer upon very and in the event of damage in transit, a claim uld be filed against the carrier at once.

warranty

Defective instruments or defective components found in the instruments will be considered for adjustment only if Sorensen & Company, Inc. is notified within the Warranty period specified. The period of Warranty (with the exception of the tubes) for this instrument is one year from date of your acceptance.

The Sorensen diode is unconditionally guaranteed for 2500 hours or one year, whichever expires first.

The instrument and materials are warranted against defective workmanship and construction, and no other warranty may be implied.

The warranty only covers equipment that is maintained in proper condition and is used by you in a skillful and proper manner. No other warranties may be implied.

procedure for returning damaged or defective material

When claiming adjustment for defective materials, the following procedure should be followed:

A. A request should be made directly to the Service Department of Sorensen & Company, Inc. for authorization to return the defective instrument. In order that your request can be serviced as quickly as possible, it is necessary to list the following information:

1 *The order number on which the instrument was shipped.*

2 *Model number and serial number of the instrument.*

3 *A brief description of the reason for rejection.*

B. It will be determined by the Service Department of Sorensen & Company, Inc. whether a repair will be attempted at your plant by one of our Field Engineers or Representatives. If this is to be done we will notify you immediately and make arrangements for a visit to your plant. If we indicate that the material is to be returned to our Plant for repair or replacement, a RETURN MATERIAL TAG which outlines shipping procedure will be sent to you.

Defective materials returned to us without RETURN MATERIAL TAG will be sent to us entirely at the risk of the customer. Repair of this instrument might be delayed if an unauthorized return is made.

C. This instrument should be packed as carefully for return as when originally received. The instruments are precision equipment and in many cases very heavy. Transformers and other components should be carefully blocked.

D. If the instrument to be returned is mounted in a cabinet, remove from the cabinet and return only the instrument. Under no circumstances (except by specific instructions from Sorensen & Company, Inc.) return both.

THE INSTRUMENT

Ratings

All ratings of units are to be found on the enclosed schematic diagrams.

Description

A. On most models a pilot light on the front panel indicates that the electronic control circuit is receiving power and that the regulator should be functioning.

B. The Screw driver adjusted control permits adjustment of output voltage setting.

C. Various methods are used in the different models to obtain input and output voltages. On low capacity units, a line cord and plug assembly is provided for input connection. Output voltage is then taken from a dual female receptacle. On larger models, the input and output terminals are to be found on the chassis. TO ELIMINATE ANY CONFUSION, REFERENCE SHOULD BE MADE TO THE SCHEMATIC DIAGRAM ENCLOSED. Inter-chassis connections for Nobatrons made up of more than one chassis can be found on the block diagrams enclosed.

D. With the exception of the Sorensen diode, all tubes are common commercial types. Diode replacements may be obtained from Sorensen & Company, Inc.

Comments

The unit is intended to operate within the loads indicated on the accompanying schematic diagram. Regulation accuracy is maintained to some degree below minimum load; however, the rated accuracy is not guaranteed except as noted.

If measurements of output voltage are taken for purposes of checking the accuracy or regulation, true RMS reading voltmeters should be used, as the regulator regulates the RMS value of the output voltage. Rectifie or vacuum-tube type voltmeters are not suitable fo this purpose. Measurements should be made directly a the output terminals and not at the end of a li leading to the load. The regulator will deliver consta voltage to its terminals regardless of load changes, b will not compensate for drop in the external wiring.

Principle of operation

The operation of the unit can best be understood, referring to the schematic diagrams included.

The basic power circuit is shown in heavy lines a includes an autotransformer T4 and a saturable c reactor T3. The reactor is in series with the prim of the autotransformer across the input termin Variation of the impedance of the saturable core reac will vary the voltage impressed on the primary of autotransformer and consequently will vary the out voltage.

A decrease in reactor impedance, for instance, will crease the portion of the input voltage impressed the autotransformer primary and will result in increase in output voltage. Conversely, an increase reactor impedance will result in a decrease in out voltage.

All that is necessary to achieve voltage regulatior some automatic method of varying the reactor impeda by the right amount to restore the output voltage to original value at such times as it may vary due changes in load or input voltage. This action is complished by the electronic control circuit.

The basic voltage sensitive element is the Wheatst Bridge. One arm of the bridge consists of the diode V2 the filament of which is lighted by the output volt In some low capacity models only two arms of bridge show on the schematic diagram. The po supply has the missing two arms by virtue of arrangement.

The diode is operated at a temperature limited co tion. With this arrangement, a small increment of ou voltage results in a change in cathode emission a large change of plate resistance in the diode. The si voltage of the bridge is applied to the grid of b power tube V2 which controls the DC saturating cur of the reactor.

A typical sequency of operations is as follows: Ass a rise in output voltage as a result of reduced loa a rise in input voltage. Increased output voltage sults in increased voltage and heating of the d filament. With increased heating, the diode catl emission increases reducing the plate resistance of tube. Since the diode forms an arm of the bridg change in plate resistance will change the bal condition of the bridge; in this instance the cha results in a more negative potential applied to the of V2. The more negative grid signal results i sharp drop in the plate current of V2 and conseque reduced saturation of the reactor. Reduced DC sat tion of the reactor results in an increase in AC impedance which, as pointed out before, lowers the output voltage.

The above action will continue until an equilibrium is reached wherein the net change in output voltage is sufficient to compensate for the changed circuit conditions in the control circuit. The gain of the control system is of such magnitude that the unit will maintain output voltage within the tolerance indicated on the schematic diagram while compensating for the rated range of input voltage and load variations.

Tubes V3 and V4 found in most models, are rectifier tubes in the DC power supplies for the saturating circuit and diode bridge circuit respectively. In some low capacity units, a miniature selenium rectifier is used. Adjustment of output voltage is accomplished by the potentiometer in the circuit supplying the diode filament. Variation of resistance in this circuit varies the value of output voltage required to obtain a given diode filament temperature, and consequently will control output voltage.

The resistor shown connected between the plate and screen of tube V2 (across terminals 9 and 10 in high capacity models) is a swamping resistor to absorb inductive surges originating in the DC reactor winding. The winding has a very high inductance.

When the regulator is first turned on, electronic circuit elements are cold and a period of approximately 60 seconds is required for the unit to reach operating temperature. During this period, the output voltage will be low; however, as the tubes begin to conduct, the output voltage rapidly rises to its proper adjusted value. This is a normal condition and in no way indicates any malfunctioning of the regulator.

Maintenance and Trouble Shooting

During normal life, the unit requires no maintenance or servicing other than the care usually afforded this type of equipment. Vacuum tubes should be replaced at the end of their specified life in accordance with the policies established for the particular application.

In the event of malfunctioning of the unit due to deterioration or failure of any of its component parts, a systematic checking procedure will provide the quickest and surest method of locating the difficulty. The following section gives systematic checking procedures which should be followed in locating sources of trouble.

The schematic shows the voltages which should exist in various parts of the circuit during normal operation. These voltages should be measured with an electronic type voltmeter.

NOTE: DANGEROUS VOLTAGES EXIST IN THE CONTROL CIRCUITS. OBSERVE APPROPRIATE PRECAUTIONS.

TROUBLE SHOOTING

THE FIRST STEP IN TROUBLE SHOOTING SHOULD BE TO REPLACE TUBES. IN MOST CASES THIS IS ENOUGH TO CURE THE TROUBLE.

problem A **No output voltage.**

This condition indicates an open in the power circuit.

procedure

1. Check that the On-Off control is in the "ON" position.
2. Check autotransformer, AC reactor coils, circuit breaker, power leads, and terminals for continuity.

problem B **No Regulation and Low Output Voltage With Load.**

No Regulation and Low Output Voltage With Load. *This condition indicates the failure of the electronic control circuit to supply saturating current.*

procedure

1. Check the fuse in the control circuit. Replace *only* with a similar type.
2. Inspect tube filaments to see that they are lit.
3. Check tubes in a tube tester or by replacement.
4. Check the DC power supply to the saturating circuit by checking the value of DC voltage. No voltage will indicate a failure of the transformer winding or of the filter condenser. Check rectifier tube.
5. Check the plate voltage and grid voltage of the beam power tube V2. If the grid voltage is abnormally negative and causing cut off, check the diode bridge supply voltage and the diode filament supply voltage.
6. Check the DC reactor winding for an open.
7. Check the over-voltage circuit breaker if one is used in your unit.
8. In the case of split-chassis construction, check the inter-chassis terminal boards for secure and correct connections.

problem C **No Regulation and High Output Voltage.**

This condition indicates that the control circuit is over-saturating the reactor. It may also be the result of shorted turns in the reactor AC coils.

procedure

1. Check to see that the diode filament is lit.
2. Check tube V2 in a tube tester or replace with a spare.
3. Check V2 grid voltage to cathode or ground. If this voltage is abnormally positive, or zero, check contacts, connections and resistance values of all components of the bridge. Check diode or replace with a spare. Check bridge rectifier.
4. Check the voltage adjusting potentiometer for dirty contacts.

problem D Drift with Age of the Range of Output Voltage.

This condition indicates a variation of tube characteristics with age.

procedure

1. Check tubes and replace accordingly.

problem E Reduction of Regulation Range or Poor Regulation in General.

These conditions may be the result of deterioration or failure of various components of the control circuit.

procedure

1. Check tubes or replace with spares.
2. Check the DC Power supply voltages.
3. Check the control circuit in general for loose connections, shorts or damaged parts.
4. Check voltage and resistance values. Check condensers by replacement.
5. The output voltage adjustable potentiometer may cause irregular output adjustment. Turn the potentiometer shaft several times in both directions as far as it will go. This is a very low resistance adjustment and contacts can oxidize enough to cause uneven control.

In the event of serious trouble or damage to the unit return it to the factory for repair and readjustment.

SORENSEN & COMPANY, INC.
375 FAIRFIELD AVENUE
STAMFORD, CONNECTICUT

MANUFACTURERS OF VOLTAGE REGULATORS, NOBATRONS AND ELECTRONIC APPARATUS